

Air Installations Compatible Use Zones Study for

NAVAL AIR STATION WHIDBEY ISLAND, AULT FIELD AND OUTLYING LANDING FIELD COUPEVILLE

Final - January 2021

NAS WHIDBEY ISLAND


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Air Installations Compatible Use Zones Study for Naval Air Station Whidbey Island, Ault Field and Outlying Landing Field Coupeville

Final – January 2021

NAS WHIDBEY ISLAND

PREPARED BY

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ES.1 INTRODUCTION

The United States Department of Defense (DOD) initiated the Air Installations Compatible Use Zones (AICUZ) Program to assist governmental entities and communities in identifying and planning for compatible land use and development near military installations. The goal of the AICUZ Program is to achieve compatibility between air installations and the community by encouraging compatible land uses that safeguard the installation's operational capabilities. Today, the AICUZ Program is a vital tool the United States Department of the Navy (Navy) uses to communicate with neighboring communities, government entities, and individuals regarding compatible land uses and development concerns.

This 2021 AICUZ Study was prepared for Naval Air Station Whidbey Island (NASWI), Washington, in accordance with federal regulations, guidelines, and Office of the Chief of Naval Operations Instruction (OPNAVINST) 11010.36C (referred to as the AICUZ Instruction), and is an update to the 2005 AICUZ Study. The scope of this AICUZ Study includes Outlying Landing Field (OLF) Coupeville, which supports operations from NASWI. Since the 2005 AICUZ Study, there have been changes that necessitate an AICUZ update. These include changes in aircraft types operating at the installation, changes in the number and types of annual aircraft operations, changes in local land use and development patterns, updates to AICUZ Program guidance and instructions, and advancements in computer-based noise modeling tools.

This AICUZ presents updated noise contours and Accident Potential Zones (APZs) for future land use planning. Noise contours and APZs, together, are commonly called the "AICUZ footprint." The 2021 AICUZ footprint is based on total operations projected out to the year 2024 based on data provided in the 2018 *Environmental Impact Statement for EA-18G "Growler" Airfield Operations at Naval Air Station Whidbey Island Complex, WA* preferred alternative and the Record of Decision, dated March 19, 2019. This AICUZ Study identifies areas of incompatible land use and recommends actions to encourage compatible land use.

ES.2 Naval Air Station Whidbey Island

NASWI is located in Island County, Washington, on Whidbey Island in the northern Puget Sound. The installation includes two main operating areas, the main air station (Ault Field) and OLF Coupeville. Ault Field is located in the north-central part of Whidbey Island, north and just outside of the city of Oak Harbor. OLF Coupeville is located approximately 10 miles south of Ault Field and southeast of the town of Coupeville.

NASWI, then U.S. Naval Air Station Whidbey Island, was commissioned on September 21, 1942, in support of American operations in World War II and has served as the home base for the Navy's tactical electronic warfare community for more than 45 years.

NASWI is the only naval air station in the Pacific Northwest and has served as the home base location for the Navy's tactical electronic warfare community, currently flying the EA-18G, for more than 45 years. NASWI's primary mission, as the sole provider of naval aviation support in the Pacific Northwest, is to provide the highest quality facilities, services, and products to the naval aviation community and all organizations utilizing the installation. NASWI supports a wide variety of tenant commands providing a diverse set of capabilities.

This AICUZ study discusses aircraft operations associated with NASWI tenant commands, as well as transient aircraft. NASWI supports electronic attack squadrons, a fleet replacement squadron, and Fleet Logistics Support Squadron 61, along with patrol and reconnaissance squadrons and a Search and Rescue (SAR) unit.

ES.3 Aircraft Operations

AICUZ studies account for future missions and operations. As such, this 2021 AICUZ Study includes current and projected aircraft that are (or will be) based at NASWI, as well as current and projected transient aircraft that operate (or will operate) at Ault Field and OLF Coupeville. Projected aircraft include aircraft new to the military inventory since 2005 (e.g., upgrades and replacements of existing platforms, increases in the number of aircraft/squadrons, and aircraft phased out and replaced by a similar aircraft). Most of the aircraft operations discussed in this AICUZ are conducted by aircraft based at NASWI, with transient aircraft making up a small percentage of total operations. Based military aircraft analyzed in this AICUZ Study include the EA-18G Growler, P-8A Poseidon, EP-3 Aries II, C-40 Clipper, and MH-60S Seahawk. The transient aircraft that most frequently use NASWI include the C-40 Clipper, various Air Mobility Command (AMC) and AMC charter aircraft, including the C-17 and C-5, and commercial 747 and 767.

Ault Field and OLF Coupeville have designated runways, and those runways have designated flight procedures that provide for the safety, consistency, and control of the airfield. A flight track is a route an aircraft follows while conducting an operation at the airfield, between airfields, or to/from a Military Operations Area (MOA) and demonstrates how the aircraft will fly in relation to the airfield. Operations conducted at Ault Field and OLF Coupeville include arrivals (straight-in, overhead break, and approach), patterns (touch-and-go, ground control approach [GCA]/carrier controlled approach [CCA], field carrier landing practice [FCLP]), interfacility operations, and departures.

"Annual operations" describe all aircraft operations that occur at NASWI during a calendar year, including based and transient aircraft. Total annual operations account for each arrival and departure, including those conducted as part of a pattern operation. This 2021 AICUZ Study provides analysis for and incorporates known and anticipated changes in mission and operations, as analyzed in the 2018 Growler EIS. Based on the changes described in the EIS, the Navy forecasts that total annual operations at NASWI will increase when compared to 2005 annual operations. As shown in Table ES-1, annual operations will increase to 112,100, with 88,000 operations at Ault Field and 24,100 operations at OLF Coupeville. Most operations (85 percent) will occur during acoustic daytime hours (7:00 a.m. to 10:00 p.m.).

TABLE ES-1 COMPARISON OF 2005 AND 2021 AICUZ STUDY ANNUAL OPERATIONS AT AULT FIELD AND OLF COUPEVILLE

	2005 AICUZ	2021 AICUZ
Ault Field	75,987	88,000
OLF Coupeville	6,120	24,100
NASWI Total	**82,107**	**112,100**

Sources:
NAVFAC Southwest 2005
Navy 2018[a]

Note:
See Chapter 3, Aircraft Operations, for more information on historic (2005) and projected (2024) operations.

ES.4 AIRCRAFT NOISE

This 2021 AICUZ Study discusses and presents noise associated with aircraft operations, including average noise levels, noise abatement/flight procedures, noise complaints, sources of noise, airfield-specific noise contours, and discusses differences between 2005 and 2021 AICUZ noise contours.

The operational data used in this AICUZ Study was collected, compiled, and input into computer models that graphically depict noise exposures as noise contours. NOISEMAP is the DOD standard model for assessing noise exposure from military aircraft operations at air installations. Operational data used in this AICUZ Study were collected from the 2018 Growler EIS preferred alternative and the Record of Decision, dated March 19, 2019. A noise study was conducted in support of the 2018 EIS to generate noise contours based on the projected operational data.

The two primary sources of aircraft noise at NASWI are ground engine maintenance "run-up" operations and flight operations. The level of noise exposure from an aircraft operation is related to the aircraft type, engine power setting, altitude flown, direction of the aircraft, duration of run-up, flight track, temperature, relative humidity, and frequency. The projected noise exposure at NASWI is primarily derived from EA-18G Growler flight operations.

The noise exposure from aircraft at the airfield is calculated using the day-night average sound level (DNL) noise metric. DNL is depicted on a map as a noise contour that connects points of equal noise value. Contours are displayed in 5-decibel (dB) increments (i.e., 60, 65, 70, 75, 80, and 85 dB DNL). The 2021 AICUZ noise contours for Ault Field overlay the area in the immediate vicinity of Ault Field and spread outward along aircraft flight tracks. The highest DNL noise contours are concentrated within or in the immediate vicinity of the installation boundary. A comparison of the 2005 and 2021 AICUZ Study noise contours shows some similarities in shape; however, the 2021 AICUZ contours have increased in overall size and coverage for both Ault Field and OLF Coupeville, as shown in this AICUZ Study, Chapter 4, Aircraft Noise (see Figures 4-5 and 4-6). These changes are attributed to several factors, including:

- Changes in aircraft types (2005 contours included aircraft no longer flown at NASWI);
- Changes in aircraft flight patterns;
- Changes in the number of aircraft;
- Changes in operational levels (the number of operations has increased from 2005 to 2021; and
- Improved noise models.

ES.5 Airfield Safety

The DOD has designated APZs covering areas near the approach and departure of military runways, as well as certain flight tracks. These APZs describe the probable impact area if an accident were to occur near the airfield; they are not a prediction of accidents or accident frequency. When adopted by local planning authorities, APZs minimize potential harm to the public, pilots, and property if a mishap does occur by limiting incompatible uses in the designated APZ areas.

APZs follow departure, arrival, and pattern flight tracks. There are three types of APZs: the Clear Zone, APZ I, and APZ II. APZs extend from the end of the runway and apply to the predominant arrival and/or departure flight tracks that the aircraft use. 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.

APZs in this 2021 AICUZ Study have been developed based on the projected annual aircraft operations presented in the 2018 Growler EIS. Approximately 5,448 acres are within the 2021 Clear Zones and APZs for Ault Field. Over 50 percent of the off-station APZ area is over the waters surrounding Whidbey Island, resulting in less than 2,000 land acres within the APZs outside the installation boundary. Overall, the total area within the APZs for Ault Field has decreased from 2005. The reduction is due to loss of APZ II coverage to the northwest (over the water) and southeast in the area of Highway 20.

In 2005, OLF Coupeville flight operations did not meet the 5,000 threshold to warrant APZ I and II. However, as an active airfield, it did require Clear Zones at each runway end. The addition of a closed-loop APZ at OLF Coupeville, as a result of the projected increase in operations, represents a substantial change from the 2005 AICUZ Study;

however, from the 1977 AICUZ to 2005, both ends of the OLF Coupeville runway supported closed-loop APZs. Approximately 2,784 acres are within the 2021 Clear Zones and APZs for OLF Coupeville. Within this AICUZ Study, see Chapter 5, Airfield Safety (Section 5.2.2, Comparison of 2005 and 2021 Clear Zones and APZs), for additional information.

ES.6 Land Use Compatibility Analysis

Successful AICUZ land use compatibility implementation is the collective responsibility of the Navy, state and local governments, and private sector and non-profit organizations. This AICUZ Study discusses federal, state, and local planning authorities, regulations, and programs that encourage compatible land use practices. Ultimate control over land use and development surrounding Ault Field and OLF Coupeville is the responsibility of local governments and landowners; therefore, the Navy encourages local governments to plan for compatible development. In addition, the Navy focuses efforts on outreach and coordination with local jurisdictions to provide greater awareness and transparency of the operations in and around the installation.

The combined AICUZ footprint (noise contours and APZs) for Ault Field and OLF Coupeville is located in unincorporated areas of Island, Skagit, and San Juan counties; the city of Oak Harbor; and the town of Coupeville. Land use planning programs, comprehensive plans, zoning codes, councils, and commissions for local jurisdictions with the potential to influence land use near the airfields are discussed as part of the AICUZ Study.

This 2021 AICUZ Study presents the land use compatibility analysis that identifies any existing or planned land use, zoning, and development compatibility issues and provides recommendations to manage existing and future development within the AICUZ footprint to ensure long-term land use compatibility between local development and the Navy's operational mission. The 2021 AICUZ footprint is discussed further in this AICUZ Study, Chapter 7, Land Use Compatibility Analysis.

The Navy has developed land use compatibility recommendations for noise zones and APZs to foster land use compatibility. For land use planning purposes in AICUZ studies, noise exposure areas are divided into three noise zones, based on DNL. Noise Zone 1 (<65 dB DNL) is an area of low or no noise exposure. Noise Zone 2 (65 to <75 dB DNL) is an area of moderate noise exposure where some land use controls are recommended. Noise Zone 3 (>75 dB DNL) is the area of highest noise exposure where the greatest degree of compatible land use controls are recommended. Likewise, recommended land use compatibility guidelines are established for Clear Zone, APZ I, and APZ II. AICUZ guidelines recommend that land uses that concentrate large numbers of people (e.g., apartments, churches, and schools) be avoided within the APZs.

This AICUZ Study addresses land use compatibility within aircraft noise zones and APZs at Ault Field and OLF Coupeville by examining existing and future land uses near the airfields. To analyze whether existing and planned land uses are compatible with aircraft operations, the 2021 AICUZ noise contours and APZs were overlaid on parcel data and land use classification information. The land use analysis was performed using the Navy's land use compatibility guidance and land use data from Island County, City of Oak Harbor, Town of Coupeville, and the State of Washington's Geospatial Open Data Portal.

Overall, land use compatibility concerns within the combined AICUZ footprint are minimal to moderate due to the strong state and local land use controls intended to direct most development to existing urban areas, protect farmland and rural land uses, and prevent incompatible development. The majority of incompatible land uses within the AICUZ footprint for Ault Field are residential uses. In the city of Oak Harbor, south of Ault Field, existing and proposed residential and mixed commercial, professional services, and public facilities may be considered incompatible in areas of high noise exposure within Noise Zone 3. Within the AICUZ footprint for OLF Coupeville, areas of incompatible existing and future land uses, particularly residential uses, are located within the noise contours and APZs. In this AICUZ Study, Chapter 7, Land Use Compatibility Analysis and Recommendations, provides a detailed land use compatibility assessment.

ES.7 Land Use Tools and Recommendations

The goal of the Navy AICUZ Program can most effectively be accomplished by the active participation of all interested parties. Federal, state, regional, and local governments, businesses, real estate professionals, and citizens, along with the Navy, all play key roles in successfully implementing the AICUZ land use compatibility study.

The Navy has the responsibility to communicate and collaborate with local governments on land use planning, zoning, and compatibility concerns that can have an impact on its mission. State and local governments have the authority to implement regulations and programs to control development and direct growth to ensure land use activity is compatible within the AICUZ footprint. Local governments are encouraged to recognize their responsibility in providing land use controls in those areas encumbered by the AICUZ footprint by incorporating AICUZ information into their planning policies and regulations. Cooperation between NASWI and neighboring communities to the airfields is key to the AICUZ Program's success. The AICUZ Study recommendations, when implemented, will continue to advance the goal, "to protect the health, safety, and welfare of those living near military airfields, while preserving the defense flying mission." More information on the specific tools and recommendations for areas of compatibility concern can be found in this AICUZ Study within Chapter 7, Land Use Compatibility Analysis and Recommendations (see Section 7.3, NASWI AICUZ Study Recommendations).

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Acronyms and Abbreviations

390 ECS	390th Electronic Combat Squadron
AICUZ	Air Installations Compatible Use Zones
Air Force	United States Air Force
Air Ops	Air Operations
APZ	Accident Potential Zone
ATC	Air Traffic Control
BASH	bird/animal aircraft strike hazard
CCA	Carrier Controlled Approach
CIP	Capital Improvement Program
CPLO	Community Planning Liaison Officer
CUP	Compatible Use Plan
CY	calendar year
CZMA	Coastal Zone Management Act
dB	decibel
dBA	A-weighted decibel
DNL	day-night average sound level
DOD	United States Department of Defense
Du/Ac	dwelling units per acre
EIS	Environmental Impact Statement
EMI	electromagnetic interference
FAA	Federal Aviation Administration
FCLP	Field Carrier Landing Practice
GCA	Ground Control Approach
GIS	Geographic Information System
GMA	Washington State Growth Management Act
HUD	United States Department of Housing and Urban Development
IRTPO	Island Regional Transportation Planning Organization
JPA	Joint Planning Area
Marine Corps	United States Marine Corps
MOA	Military Operations Area
MSL	mean sea level

NAS	Naval Air Station
NASWI	Naval Air Station Whidbey Island
NATOPS	Naval Air Training and Operating Procedures Standardization
NAVAIR	Naval Air Systems Command
NAVFAC	Naval Facilities Engineering Command
Navy	United States Department of the Navy
NEPA	National Environmental Policy Act
nm	nautical mile
nm^2	square nautical miles
NWSTF	Naval Weapons Systems Training Facility
OLF	Outlying Landing Field
R-	Restricted Area
RAID	Rural Areas of More Intensive Development
RCW	Revised Code of Washington
REPI	Readiness and Environmental Protection Integration
RTPO	regional transportation planning organization
SAR	Search and Rescue
SLUCM	Standard Land Use Coding Manual
SUA	Special Use Airspace
TDR	transfer of development rights
U.S.C.	United States Code
UAS	Unmanned Aircraft System(s)
UGA	Urban Growth Area
USFWS	United States Fish and Wildlife Service
VR-61	Fleet Logistics Support Squadron 61

1 INTRODUCTION

1.1 AICUZ Program
1.2 Responsibility for Compatible Land Use
1.3 NAS Whidbey Island AICUZ Studies Overview

Many areas throughout the United States have experienced population growth and increased development in proximity to a military installation, as is the case with Naval Air Station Whidbey Island (NASWI). This growth typically takes the form of new residential development and expanded commercial development. New homes are constructed near an installation to allow both military and civilian personnel who work at a base to live near their employer. Similarly, businesses are established in proximity to these homes and the military installation to support the installation and its personnel and to service new residential growth. Development located near an installation may be incompatible with aircraft and other military operations that occur at the base and, over time or if not managed appropriately, can result in conflict between military operations and the local community.

The United States Department of the Navy (Navy) actively supports programs to minimize incompatible development and noise impacts, including the requirement that each air station implement and maintain an Air Installations Compatible Use Zones (AICUZ) Program. The AICUZ Program was instituted by the United States Department of Defense (DOD) in response to incompatible development around military airfields across the country and to help governmental entities and communities anticipate, identify, and promote compatible land use and development near military installations. While also protecting the operational capabilities of the military, the goal of this Program is to achieve compatibility between air installations and the community by encouraging compatible land uses that safeguard the installation's operational capabilities. This goal is accomplished by achieving compatible land use patterns and activities around an air installation.

The AICUZ Program recommends that noise contours, Accident Potential Zones (APZs), height obstruction criteria, and associated land use recommendations be incorporated into local community planning programs in order to minimize impacts to the mission and the residents in the surrounding community. Mutual cooperation between military airfield planners and community-based counterparts serves to increase public awareness of the importance of air installations and the need to address mission requirements and associated noise and risk factors. As the communities that surround airfields grow and develop, the Navy has the responsibility to communicate and collaborate with the local government on land use planning, zoning, and similar matters that could affect the installations' operations or missions.

The 2021 Naval Air Station (NAS) Whidbey Island AICUZ Study is an update to the 2005 AICUZ Study (Naval Facilities Engineering Command [NAVFAC] Southwest 2005). This AICUZ Study addresses past and expected changes in mission and aircraft, and projected operational levels approved in the Record of Decision for the EA-18G Growler Airfield Operations Environmental Impact Statement (EIS). This AICUZ uses the projected 2024 aircraft operational levels and noise contours of the Growler EIS Record of Decision as a reasonably foreseeable long-term planning projection for this AICUZ planning document.

> **The overall goal of the AICUZ Program is to achieve compatibility between air installations and the community by encouraging compatible land uses that safeguard the installation's operational capabilities.**

This AICUZ Study provides background on the AICUZ Program, historical data from the previous AICUZ Study and other related documents, and changes that require an AICUZ Update (Chapter 1, Introduction). Chapter 2, Naval Air Station Whidbey Island, describes the location and installation features of NASWI, including airspace and operational areas. Aircraft types, operations, and flight tracks are discussed in Chapter 3, Aircraft Operations. Chapter 4, Aircraft Noise, presents the updated aircraft noise contours, outlining the methodology for determining noise, what changes have occurred, and what the future expectations are for change, as well as what measures have been implemented by the Navy to mitigate some community noise concerns. Aircraft safety issues and the development of APZs are discussed in Chapter 5, Airfield Safety. Chapter 6, Land Use Authorities, Policies, Regulations, and Programs, evaluates the compatibility of both current and proposed land uses, as provided by local governments. Chapter 7, Land Use Compatibility Analysis and Recommendations, provides recommendations for promoting land use compatibility consistent with the goals of the AICUZ Program, and the last section, Chapter 8, References, is a list of references used in this AICUZ Study.

1.1 AICUZ Program

The DOD established the AICUZ Program to balance the need for aircraft operations with community concerns regarding aircraft noise and accident potential. The AICUZ Program provides a format to document the effects of aircraft operations in a community, while encouraging compatible development to minimize future conflicts.

The objectives of the AICUZ Program, according to the Office of the Chief of Naval Operations Instruction (OPNAVINST) 11010.36C, are:

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

To meet the objectives of the AICUZ Program, the Navy recommends that local community planning authorities incorporate development criteria in areas surrounding a base and incorporate noise exposure contours and APZs into local plans and development ordinances. Noise exposure contours and APZs, which are described in detail in Chapters 4 and 5, respectively, are compatible land use planning areas for an air installation and its neighboring communities. Since noise exposure contours and APZs often extend beyond the "fence line" of an installation, presenting current noise exposure contours and APZs to local governments is essential to fostering mutually beneficial land uses and development

To address safety concerns around airfields, the Federal Aviation Administration (FAA) and DOD have developed specific instructions and guidance to encourage local communities to restrict development or land uses that could endanger flight safety. Potential dangers include: lighting (direct or reflected) that would impair pilot vision; towers, tall structures, and vegetation that penetrate navigable airspace or are constructed near an airfield; uses that generate smoke, steam, or dust; uses that attract birds, especially waterfowl; and electromagnetic interference (EMI) sources that may adversely affect aircraft communication, navigation, or other electrical systems. This topic is discussed in more detail in Section 5.4, Flight Safety.

1.1.1 Purpose, Scope, and Authority

The purpose of the AICUZ Program is to achieve compatibility between air installations and neighboring communities. To satisfy this purpose, the Navy works with the local communities to foster compatible development.

The scope of this AICUZ Study includes:

- 2005 and 2021 aircraft operations;
- Noise contours;
- APZs; and
- Land use analysis and compatible land use recommendations.

An AICUZ study presents analysis of community development trends, land use tools, and mission requirements to recommend strategies for communities to prevent incompatible development. Implementation of these strategies requires cooperation between the Installation Commanding Officer, Community Planning Liaison Officer (CPLO), and local governments. Key documents that outline the authority for the establishment and implementation of the AICUZ Program, as well as guidance on facility requirements, include:

- DOD Instruction 4165.57, "Air Installations Compatible Use Zones," dated August 31, 2018;

- OPNAVINST 11010.36C, "Air Installations Compatible Use Zones Program," dated October 9, 2008;
- Unified Facilities Criteria 3-260-01, "Airfield and Heliport Planning and Design," dated May 5, 2020;
- Unified Facilities Criteria 2-000-05N Facility Planning Criteria for Navy/Marine Corps Shore Installations, Appendix E Airfield Safety Clearances P80.3, dated January 1, 1982; and
- United States Department of Transportation, FAA Regulations, Code of Federal Regulations, Title 14, Part 77, "Objects Affecting Navigable Airspace."

> The Navy's AICUZ Program Instruction (OPNAVINST 11010.36C) governs the AICUZ Program and provides guidelines for compatible land use.

1.2 Responsibility for Compatible Land Use

The AICUZ Program promotes compatible land use development around military air installations through mutual cooperation and engagement with the community. Therefore, ensuring land use compatibility near an air installation is a collaborative effort by many organizations and groups, including the DOD, Navy, local naval installation command, state and local governments, planning and zoning agencies, developers, real estate agencies, and residents.

State and local governments are responsible for protecting public health, safety, and welfare. The Navy shares these concerns and works cooperatively with local government to ensure that the Navy mission and installation operations are conducted safely. The Navy actively works with state and local government agencies to engage and inform the local communities throughout the development and implementation of compatible land use recommendations that reduce noise exposure and ensure safety around air installations. While military installations can advise local government agencies on land use near the installation by providing information on aircraft noise and accident potential, it is state and local government agencies that have the authority to preserve land use compatibility through the adoption and implementation of appropriate control measures recommended in this AICUZ Study.

> Military installations can make recommendations or advise local governments and agencies on land use near an installation, but it is the local government and agencies that have the planning and zoning authority to preserve land use compatibility near the military installation.

Cooperative action by all parties is essential in promoting compatible land use and deterring potential hazards. Chapter 7, Land Use Compatibility Analysis and Recommendations, discusses the Navy's compatible land use tools and recommendations in more detail.

1.3 NAVAL AIR STATION WHIDBEY ISLAND STUDIES OVERVIEW

Updates to an AICUZ study account for changes in aircraft that utilize an installation, changes in operational parameters, and changes derived from revisions to the Navy AICUZ Instruction. Since the inception of the AICUZ Program in 1973, Naval Air Station Whidbey Island (NASWI) has experienced many mission and operational changes, and has undergone three complete AICUZ studies. The following sections highlight the AICUZ Study history at the airfield, describe the changes that require an AICUZ study update, summarize the changes that necessitate this AICUZ Study update, and provide an overview of this document.

1.3.1 PREVIOUS AICUZ EFFORTS AND RELATED STUDIES

Three AICUZ studies have been completed for NASWI since the inception of the AICUZ Program. The following sections present the key elements of these three AICUZ studies.

1977 AICUZ STUDY FOR NAVAL AIR STATION WHIDBEY ISLAND'S AULT FIELD AND OLF COUPEVILLE

This original AICUZ Study, published in 1977, was prepared following the establishment of the DOD AICUZ Program under the authority of the 1975 DOD Instruction. The 1977 AICUZ Study served as the basis for the installation's AICUZ Program and formalized the installation's communication and outreach with the local communities. The original AICUZ Study established the AICUZ footprint for Ault Field and Outlying Landing Field (OLF) Coupeville (NAVFAC Southwest 2005).

1986 AICUZ STUDY UPDATE FOR NAVAL AIR STATION WHIDBEY ISLAND'S AULT FIELD AND OLF COUPEVILLE

The 1986 AICUZ Study Update incorporated changes to the installation's AICUZ footprint based on changes in aircraft types and operations. The predominant fixed-wing and rotary-wing aircraft operating out of NASWI at the time included the A-6E, EA-6B, P-3C, C-12F, TC-4, and H-3s. Following the 1986 AICUZ Study Update, Island County and the City of Oak Harbor evaluated the AICUZ recommendations and enacted some compatible land use provisions into their zoning ordinances (NAVFAC Southwest 2005).

2005 AICUZ STUDY UPDATE FOR NAVAL AIR STATION WHIDBEY ISLAND'S AULT FIELD AND OUTLYING LANDING FIELD COUPEVILLE, WASHINGTON

The 2005 AICUZ Study Update incorporated changes in the APZs at Ault Field and OLF Coupeville resulting from changes in operations and updated operator descriptions of flight tracks. The 2005 AICUZ Study Update was published under the authority of the 1977 DOD Instruction and the 2002 OPNAVINST 11010.36B (NAVFAC Southwest 2005).

The study presented an analysis of noise and safety effects based on existing conditions for calendar year (CY) 2003, and projected noise contours and APZs based on operational conditions expected to occur in CY 2013 once the Navy fully transitioned from the EA-6B to the EA-18G. The projected conditions also took into account the elimination of C-12 aircraft operations at NASWI (NAVFAC Southwest 2005).

Since the 1986 AICUZ Study Update, the installation experienced changes in operational and training requirements, aircraft mix, tempo of aircraft operations, and maintenance procedures, along with changes in surrounding community development and land use. During development of the 2005 AICUZ Study Update, the most frequently used aircraft at the installation included upgraded EA-6B and P-3 platforms (P-3C and EP-3E), the C-9B, and the UH-3H. The EA-6B was scheduled to be retired beginning in 2010 and replaced by the EA-18G. As the basis for the aircraft operations and noise analysis, the study used the 2004 Aircraft Noise Study for NASWI and OLF Coupeville, Washington, which was completed to project changes in noise contours due to the transition from the EA-6B to the EA-18G (NAVFAC Southwest 2005).

2018 Environmental Impact Statement for EA-18G "Growler" Airfield Operations at Naval Air Station Whidbey Island Complex, Washington preferred alternative and the Record of Decision, dated March 19, 2019.

The 2018 Growler Environmental Impact Statement (EIS) proposed the continuation and expansion of existing Growler operations at the NAS Whidbey Island Complex, including Growler aircraft participation in Field Carrier Landing Practice (FCLP) at Ault Field and OLF Coupeville; increases in electronic attack capabilities through the addition of 36 aircraft to support an expanded DOD mission for identifying, tracking, and targeting in a complex electronic warfare environment; construction and renovation of facilities at Ault Field to accommodate additional Growler aircraft; and stationing of additional personnel and their family members at the NAS Whidbey Island complex and in the surrounding community.

This AICUZ uses the projected 2024 aircraft operational levels and noise contours of the Growler EIS Record of Decision as a reasonably foreseeable long-term planning projection for this AICUZ planning document.

1.3.2 Changes that Necessitate this AICUZ Update

AICUZ updates follow DOD and Navy Instructions. Updates are determined to be necessary based on a variety of factors, primarily if an air installation has a significant change in aircraft operations, a significant increase in acoustic nighttime flying activities, a change in the aircraft based and operating at the installation, or changes in flight paths or runway utilization. Another critical determining factor is an installation's acquisition or discontinuation of a mission that affects aircraft operations. Other factors to consider include the year of the previous AICUZ study, updates to the DOD or Navy Instruction, updates to noise modeling methods, and local community land use changes and developments.

This AICUZ Study was developed in accordance with OPNAVINST 11010.36C and is a formal update to the 2005 AICUZ Study Update. This updated study discusses projected aircraft operations at NASWI, including Ault Field. The justifications for the update include the following:

- The 2005 AICUZ Study Update is 15 years old.
- AICUZ Program guidance and instructions have been updated since publication of the 2005 AICUZ Study Update:
    - DOD Instruction was updated in 2018;
    - OPNAVINST was updated in 2008; and
    - Unified Facilities Criteria 3-260-01 was updated in 2019.
- Advancements in the DOD NOISEMAP suite of computer-based noise modeling tools that are used to generate the AICUZ noise contours:
    - Updated aircraft acoustical data;
    - Addition of terrain into noise modeling; and
    - Improved geographical technology.

  (Note: The Noise Study referenced in this AICUZ Study utilized Version 7.3 of NOISEMAP.)
- Significant changes in aircraft types operating at the installation since the 2005 AICUZ Study Update, including replacement of the P-3C with the P-8A and homebasing additional EA-18G at the installation as evaluated in the *2018 Final Environmental Impact Statement for EA-18G Growler Airfield Operations at NASWI Complex* (Navy 2018[a]).
- Changes in the number and types of annual aircraft operations.
- Changes in the local land use and development patterns.
- The need for public outreach materials to communicate changes in operations and the noise contours and APZs at the installation.

These factors have differing effects on the noise contours and APZs, commonly called the AICUZ footprint. These effects, as well as the extent of changes from the 2005 AICUZ Study Update, are discussed further in Chapters 3, 4, and 5.

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2 Naval Air Station Whidbey Island

2.1 Location and History

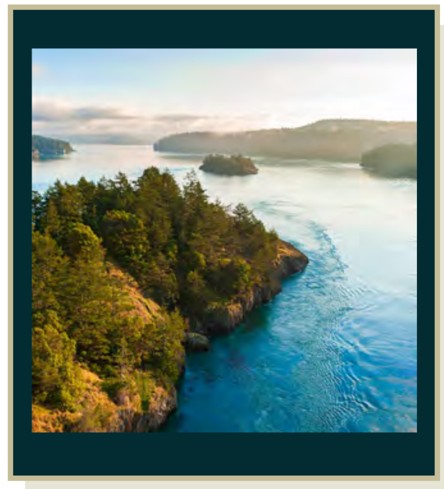
2.2 Mission and Installation Activities

2.3 Operational Areas

2.4 Local Economic Impacts and Population Growth

2.1 Location and History

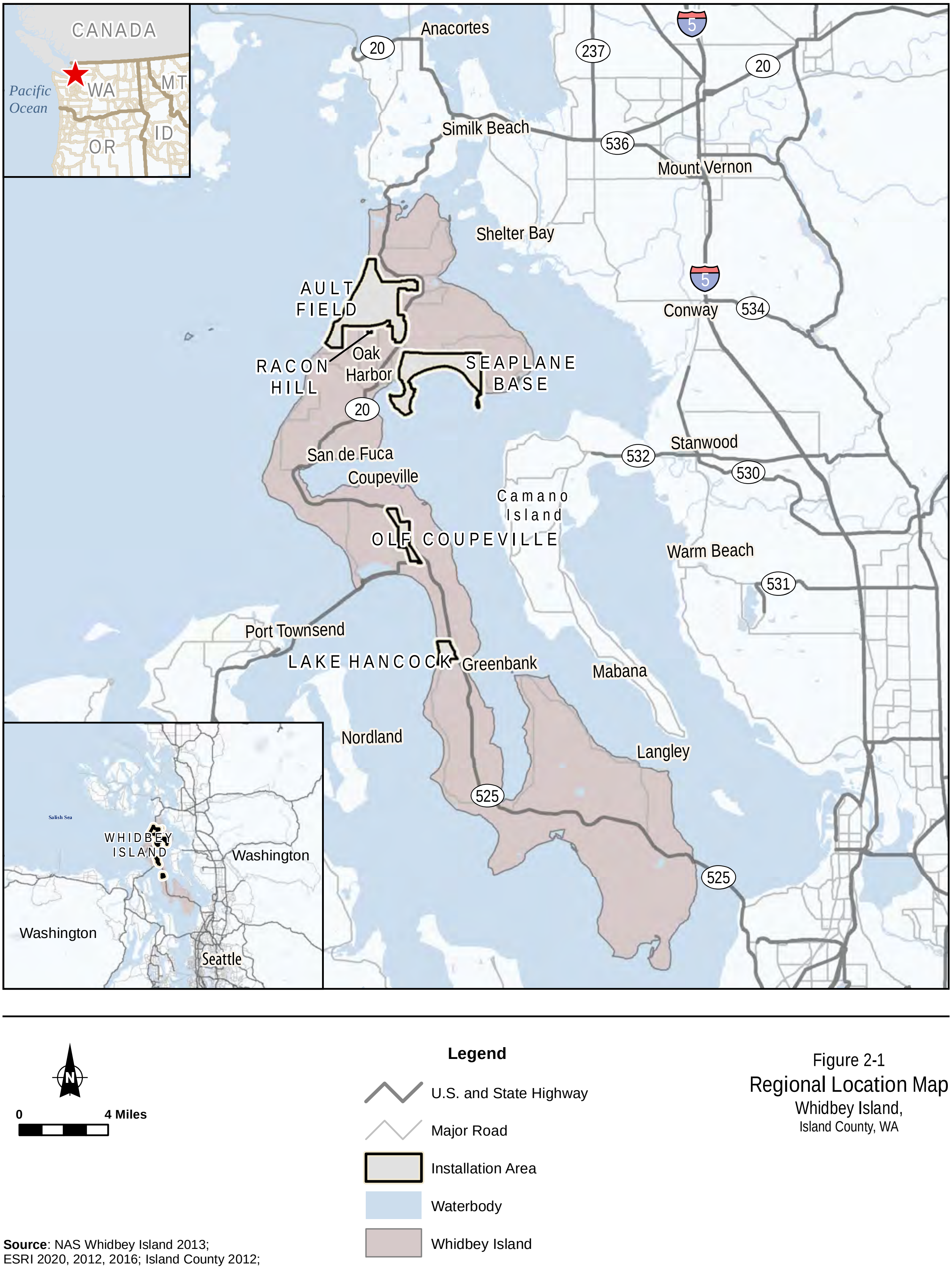
NASWI is located in Island County, Washington, on Whidbey Island in the northern Puget Sound (Figure 2-1). The installation includes two main operating areas, the main air station (Ault Field) and OLF Coupeville. Ault Field is located in the north-central part of Whidbey Island, adjacent to the city of Oak Harbor. OLF Coupeville is located approximately 10 miles south of Ault Field and southeast of the town of Coupeville.



On December 8, 1941, the day after the Japanese attack on Pearl Harbor, survey work started in Clover Valley on Whidbey Island, in the area that would become Ault Field. Construction of the airfield began on March 1, 1942, and the installation, then called U.S. Naval Air Station Whidbey Island, was commissioned on September 21, 1942. Construction of Outlying Field Coupeville southeast of Coupeville started in March 1942, and the airfield was in use as an auxiliary field to serve Naval Station Seattle by September of that year (Navy n.d.).

Following World War II, in 1949, the Navy chose NASWI as the only major fleet support station north of San Francisco and west of Chicago, supporting fleet and Alaska activities. Between 1949 and the early 2000s, the installation supported a variety of aircraft types and missions. The first EA-6B squadron was established at the airfield in 1970. NASWI's EA-6B squadrons assumed the primary mission of electronic attack. The first EA-18G, the replacement for the EA-6B aircraft, arrived at NASWI in 2007, and the transition from the EA-6B to the EA-18G was completed in 2015. The patrol and reconnaissance wing flying the P-3 has operated out of NASWI since 1993. The wing began to transition from the P-3 to the P-8A starting in 2012, and that transition was completed in 2019 (Navy n.d.). Today NASWI is the only naval air station in the Pacific Northwest and has served as the home base location for the Navy's tactical electronic warfare community for more than 45 years.

NASWI, then U.S. Naval Air Station Whidbey Island, was commissioned on September 21, 1942, in support of American operations in World War II and has served as the home base for the Navy's tactical electronic warfare community for more than 45 years.



Source: NAS Whidbey Island 2013; ESRI 2020, 2012, 2016; Island County 2012; Washington State Department of Ecology 2014.

Figure 2-1
Regional Location Map
Whidbey Island,
Island County, WA

2.2 Mission and Installation Activities

NASWI's primary mission, as the sole provider of naval aviation support in the Pacific Northwest, is to provide the highest quality facilities, services, and products to the naval aviation community and all organizations utilizing the installation. The installation offers a variety of services required to operate and maintain a fully functioning airfield, including mission support and facilities, environmental resources management, and personnel and family support services. Tenant commands at NASWI with aircraft operations are discussed below.

2.2.1 Tenant Commands

NASWI supports a wide variety of tenant commands providing a diverse set of capabilities. NASWI supports electronic attack squadrons, a fleet replacement squadron, and Fleet Logistics Support Squadron 61, along with patrol and reconnaissance squadrons and a Search and Rescue (SAR) unit.

Commander Electronic Attack Wing Pacific

Electronic attack squadrons flying the EA-18G Growler support the Commander, Naval Air Forces, and combatant commanders worldwide. They also provide electronic warfare tactical and technical development leadership and expertise. As Type Wing Commander of all Navy EA-18G fleet squadrons and the fleet replacement squadron and Operational Commander of four expeditionary squadrons, the Commander Electronic Attack Wing Pacific is engaged in a variety of activities including maintenance, material and operational readiness support, and everyday administrative functions. NASWI is home to all Navy EA squadron except for one operational squadron that is permanently forward deployed to the Western Pacific onboard the USS Ronald Reagan (CVN 76), home ported in Japan.

390th Electronic Combat Squadron

The 390th Electronic Combat Squadron (390 ECS) is the parent command for all United States Air Force (Air Force) personnel stationed at NASWI. Airmen under the 390 ECS have been embedded within the Navy's electronic attack squadrons at NASWI since 1998. They provide logistical expertise and flying the EA-18G in support of the Joint Airborne Electronic Attack Program. The squadron's mission is to provide administrative and logistical support for assigned Air Force personnel and to support the expeditionary electronic attack squadron. The 390 ECS is a geographically separated unit of the 366th Operations Group, an F-15E fighter group located at Mountain Home Air Force Base, Idaho.

Commander Patrol and Reconnaissance Wing 10

The Commander Patrol and Reconnaissance Wing 10 maintains operational and administrative control of all active duty and reserve P-8A and P-3C patrol aviation and EP-3 fleet air reconnaissance squadrons stationed at NASWI. The Wing is also responsible for the training, maintenance, and administrative support of its assigned squadrons of more than 2,000 personnel. The Wing provides operations support and communication to its squadron through a tactical support center that contains the most advanced systems in the Pacific Fleet, providing mission planning, briefing, and analysis tools for combat aircrews, and an extensive communications suite.

Squadrons deploy to sites located in the Western Pacific, Persian Gulf, and Indian Ocean. Between deployments, aircrews train by maintaining proficiency in antisubmarine warfare operations, surface surveillance, battle group coordinated operations, intelligence collection, counter-narcotics, and mine warfare.

Fleet Logistics Support Squadron 61

Fleet Logistics Support Squadron 61 (VR-61) is one of four Navy Reserve C-40 squadrons. VR-61 includes full-time support and selected reserve personnel who maintain and operate three C-40 aircraft providing worldwide, around-the-clock transport of passengers and cargo in support of all branches of the Armed Forces. VR-61 is under the operational control of Commander, Fleet Logistics Support Wing.

NASWI Search and Rescue

NASWI SAR is a one-of-a-kind rescue unit. With a team consisting of three MH-60S helicopters, ten pilots, ten rescue aircrewmen and three SAR medical technicians, they are the premier SAR unit in the Navy. The unit’s primary mission is to be the first responder for the aircraft and personnel stationed at NASWI. The unit also works closely with local agencies to provide emergency response within the region. In 2020, SAR performed 56 missions rendering emergency response for civilians. NASWI SAR typically maintains either a 15-minute or a 30-minute alert posture in order to fulfill its mission.

The unit’s pilots and aircrew are highly trained in both overwater and mountain rescue, including helicopter rappel, hoist, and mountain landing. The unit can conduct day or night operations and has night vision goggle capability.

2.2.2 Projected Activities

This AICUZ uses the projected 2024 aircraft operational levels and noise contours of the Growler EIS Record of Decision as a reasonably foreseeable long-term planning projection for this AICUZ planning document.

2.3 Operational Areas

In March 1942, work started on the airstrip that would become NASWI's first runway. Today the airfield, now known as Ault Field, supports based and transient aircraft at the installation. In addition to the airfield, NASWI's primary operational areas include the airspace surrounding the installation, designated military training airspace, and OLF Coupeville. Ault Field is located approximately 10 miles north of OLF Coupeville and 10 miles southwest of Anacortes Airport. Relative to large commercial airports, Ault Field is located approximately 63 miles southeast of Vancouver International Airport, 41 miles southeast of Victoria International Airport, and 65 miles north of Seattle-Tacoma International Airport. The following sections discuss NASWI's general airfield features, airspace, and features of OLF Coupeville.

2.3.1 Ault Field

Ault Field (Figure 2-2) has an elevation of 47 feet above mean sea level (MSL). The airfield has two intersecting runways, Runway 07/25 and Runway 14/32 (Figure 2-2). Both runways are 8,000 feet long and 200 feet wide. Runways are numbered according to their magnetic heading for aircraft on approach or departure. Aircraft generally take off into the wind for optimum safety and performance. Prevailing surface winds at Ault Field are from the southeast between October and March and from the southwest between April and September. Therefore, prevailing wind directions and NASWI's noise-abatement procedures (see additional discussion in Section 4.3.1, Noise Abatement) result in Runways 25 and 14 being the most frequently used runways at the airfield. Approximately 46 percent of airfield operations are assigned to Runway 25, and 32 percent are assigned to Runway 14. Runways 07 and 32 are used less frequently. Approximately 16 percent of airfield operations occur on Runway 07, and 6 percent occur on Runway 32.

DOD fixed-wing runways are separated into two classes, Class A and Class B. Class A runways are primarily used by light aircraft and do not accommodate intensive use by heavy or high-performance aircraft. Class B runways constitute all other fixed-wing runways not classified as Class A and are intended for use by high-performance and large, heavy aircraft. Runways at NASWI are Class B runways.

The airfield and tower are open seven days per week, 24 hours per day.

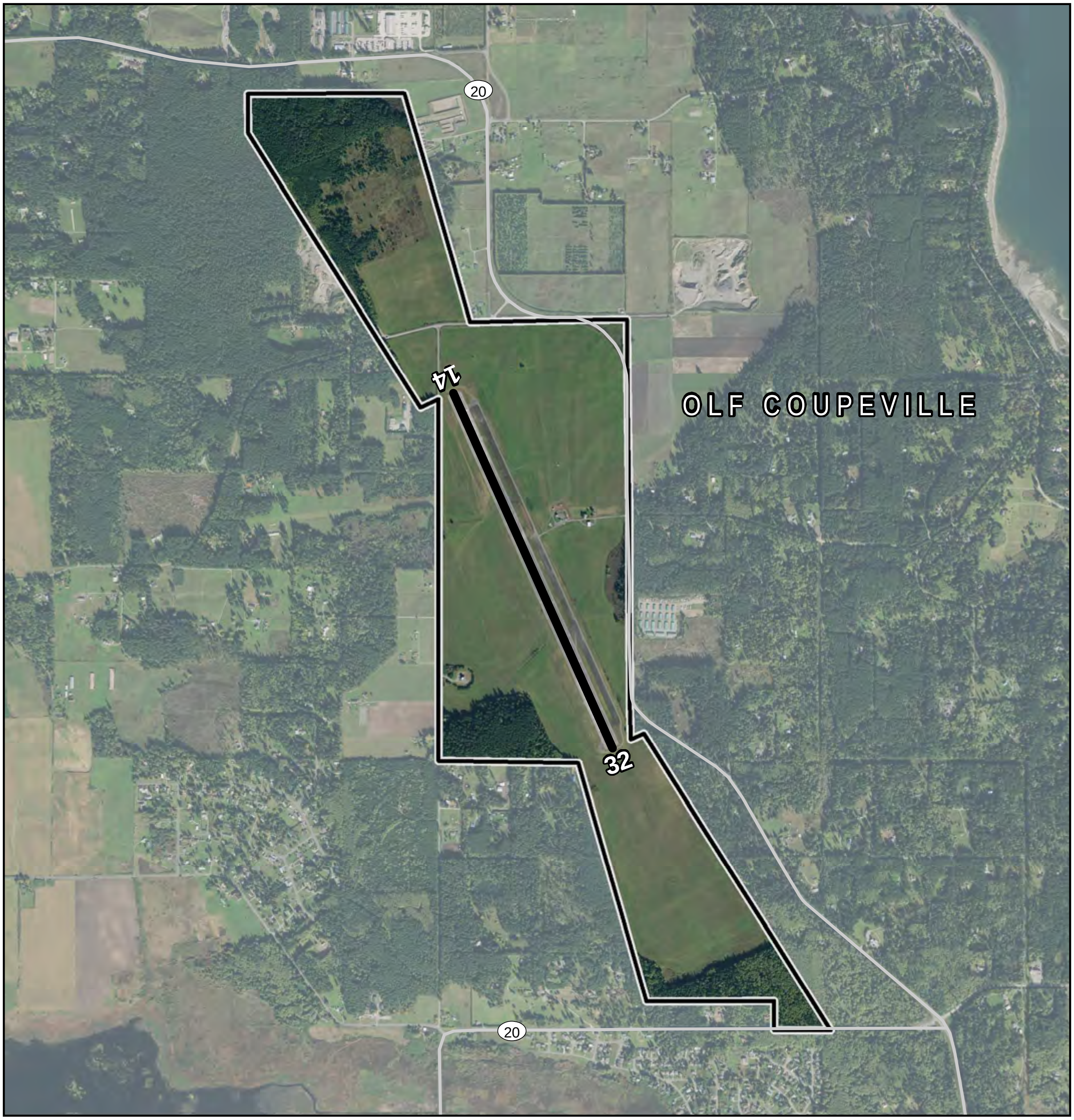
Figure 2-2
Ault Field,
NAS Whidbey Island
Whidbey Island,
Island County, WA

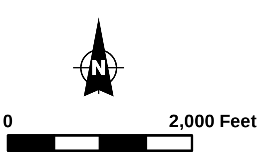
Source: NAS Whidbey Island 2013c;
ESRI 2020, 2012, 2016; Island County 2012;
Washington State Department of Ecology 2014.

2.3.2 OLF Coupeville

OLF Coupeville (Figure 2-3), at an elevation of 199 feet above MSL, has one Class B runway, Runway 14/32. The runway is 5,400 feet long and 200 feet wide. OLF Coupeville is primarily used for FCLP by EA-18G aircrews. While OLF Coupeville is available for use seven days per week, 24 hours per day, several noise-abatement procedures have been adopted in recent years, including the publishing of FCLP schedules and, when practicable, avoiding conducting operations on school test days and weekends. Use of OLF Coupeville is determined by operational requirements and, similar to Ault Field, runway use is determined by prevailing winds and the performance characteristics of the EA-18G. Based on historical meteorological conditions at the OLF, runway utilization for Runway 32 is approximately 70 percent of operations and Runway 14 is used for approximately 30 percent of operations.

The airspace above OLF Coupeville is designated as Alert Area-680, a Special Use Airspace (SUA) designation that indicates the airspace may contain a high-volume or an unusual type of pilot training activities (Figure 2-5). The Alert Area airspace around OLF Coupeville extends upward from the surface to 3,000 feet above MSL and within a 1.5-nautical mile (nm) radius of the airport in all directions.





Legend

- Highway
- Runway
- Installation Area

Figure 2-3
OLF Coupeville,
NAS Whidbey Island
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020c; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

2.3.3 AIRSPACE

The use of airspace over NASWI and OLF Coupeville is dictated by the FAA's National Airspace System and seeks to ensure the safe, orderly, and efficient flow of commercial, private, and military aircraft. There are two categories of airspace: regulatory and non-regulatory. Within these two categories, there are four types of airspace: controlled, uncontrolled, special use, and other airspace. Controlled airspace, designated Class A through Class E, covers the airspace within which Air Traffic Control (ATC) clearance is required. Uncontrolled airspace is the portion of the airspace not designated as Class A through Class E within which ATC has no authority or responsibility to control air traffic (FAA 2014) (Figure 2-4).

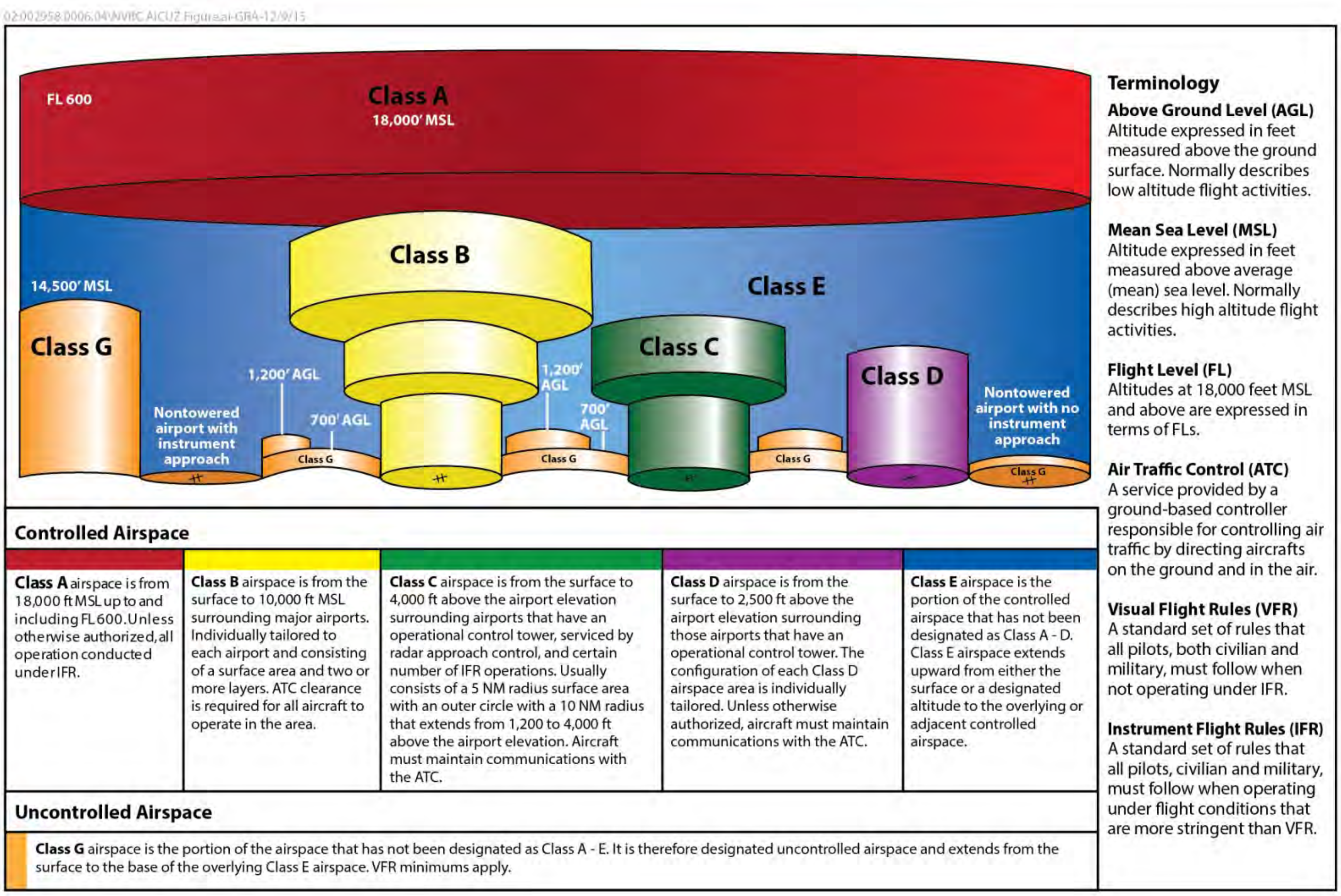


FIGURE 2-4 GENERAL AIRSPACE CLASSIFICATIONS

The controlled airspace under the jurisdiction of an airfield's control tower and serviced by radar approach control is defined by the FAA as Class C airspace. NASWI's Class C airspace extends:

- From the surface to 4,000 feet above MSL within a radius of 5 nm of Ault Field;
- Upward from 1,300 feet above MSL within a 10-nm radius of the airfield from the 050° bearing (toward Bay View in Skagit County) from the airport clockwise to the 345° bearing (toward Cypress Island) from the airfield; and

- Upward from 2,000 feet above MSL to 4,000 feet above MSL within a 10-nm radius of the airfield from the 345° bearing from the airport clockwise to the 050° bearing from the airfield.

Within designated airspace, many factors determine flight pattern altitudes, such as designation of flight corridors, distance between takeoff and landing locations, mission, and other air traffic. Other than during takeoff and landing, low-altitude flight is conducted only for specific training requirements in approved areas and on approved routes. The NASWI ATC Facility, located at Ault Field, provides ATC services to all aircraft operating within the Class C airspace. The NASWI ATC Facility is responsible for the safe, orderly, and expeditious flow of both civil and military air traffic and provides the en route traffic control service within 2,100 square miles of airspace surrounding NASWI's Class C airspace.

SUA is the designated airspace within which certain activities must be confined, or where limitations may be imposed on aircraft operations that are not part of those activities. SUA dimensions are defined so that military activities can operate and have boundaries that limit access by non-participating aircraft. Restricted Areas (R-) are designated where operations are hazardous to non-participating aircraft and contain airspace within which the flight of aircraft, while not wholly prohibited, is subject to restrictions. A Military Operations Area (MOA) is established to separate certain non-hazardous military activities from Instrument Flight Rule (IFR) aircraft traffic and to identify for Visual Flight Rule (VFR) aircraft traffic where military activities are conducted. MOAs exist at altitudes up to, but not including, 18,000 feet above MSL. Civilian VFR traffic is allowed in MOAs, in which case both civilian and military aircraft use "see-and-avoid" procedures. Generally, civilian pilots avoid flying through MOAs because of the likelihood of encountering a fast-moving military jet. An operating area is a designated area offshore, including subsurface and surface training ranges and SUA, where military training exercises and system qualification tests are routinely conducted (Figure 2-5).

The training areas near NASWI that support squadrons operating out of Ault Field include:

- Naval Weapons Systems Training Facility (NWSTF) Boardman/R-5701/Boardman MOA. This range provides more than 47,000 acres of land and approximately 360 square nautical miles (nm^2) of SUA. The property was formally transferred from the Air Force to the Navy in November 1960. NWSTF Boardman is the principal regional air-to-ground range, providing the only terrestrial impact area and restricted low-altitude training airspace for use by NASWI-based student and fleet aircrews. NWSTF Boardman and its associated airspace also support occasional training requirements of other DOD units, and the SUA is used by DOD offices to conduct Unmanned Aircraft System (UAS) testing and training.
- Northwest Training Range Complex, including overland and overwater SUA, seaspace, and mobile threat emitter simulators. This range complex covers more than approximately 122,000 nm^2 of airspace, including:
    - Darrington Operating Area. This area is a stationary altitude reservation activated through the FAA for Growler use for functional check flights and electronic counter-measure training.
    - Olympic, Okanagan, and Roosevelt MOAs, including associated ATC Assigned Airspace. These areas provide more than approximately 11,000 nm^2 of airspace and represent the primary area for EA-18G training.
    - Pacific Northwest Electronic Warfare Range. This area includes electronic emitters that transmit signals skyward to EA-18G aircraft for aircrews to detect, locate, and identify.

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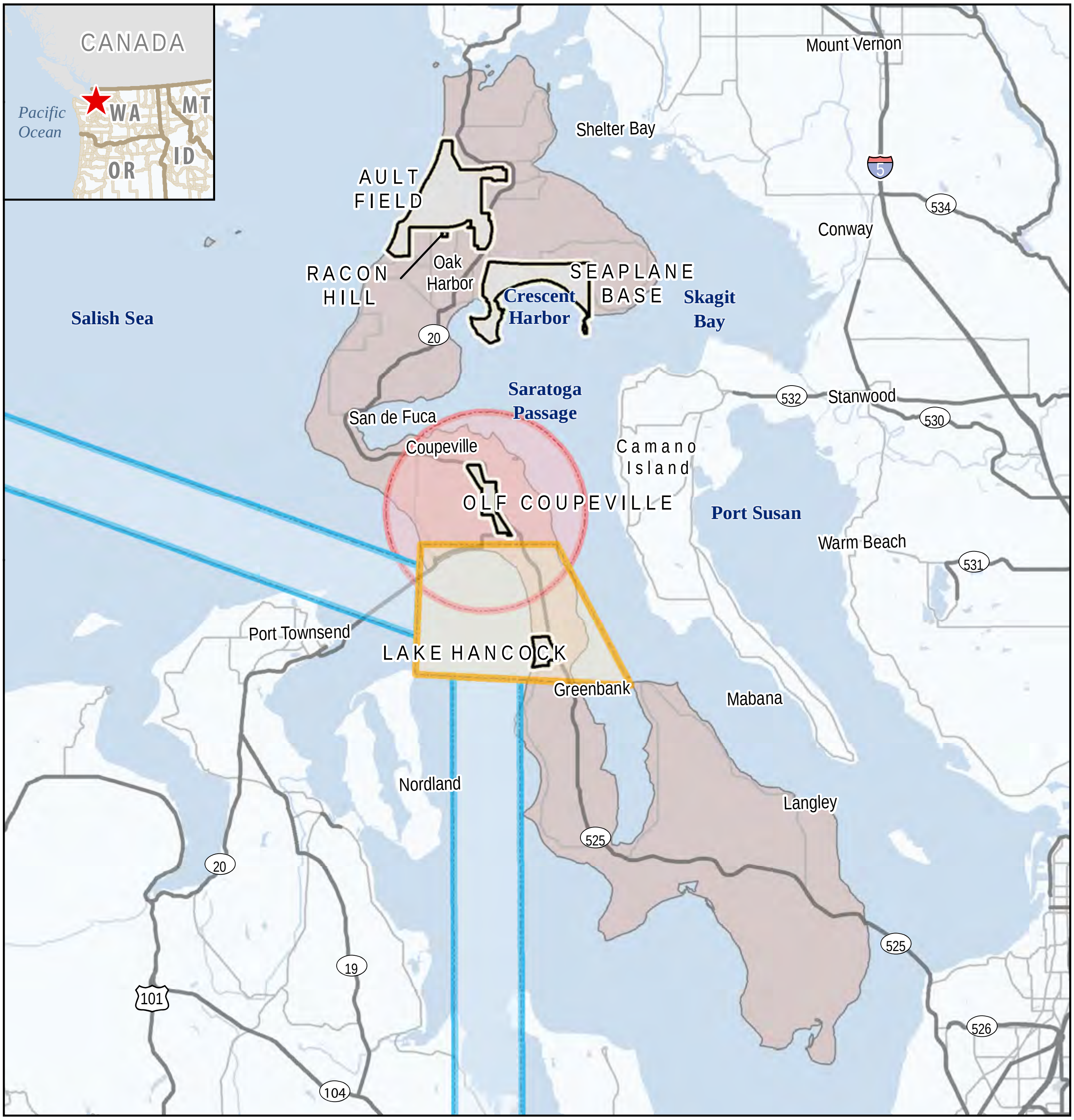


Legend

U.S. and State Highway
Major Road
Installation Area
Whidbey Island
Waterbody

Airspace Classification
Alert Area
Military Operations Area
Restricted Area

Figure 2-5
Airspace Classification, NAS Whidbey Island
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2013c; ESRI 2020, 2012, 2016; Island County 2012; Washington State Department of Ecology 2014.

2.4 LOCAL ECONOMIC IMPACTS AND POPULATION GROWTH

The military provides direct, indirect, and induced economic benefits to the regional and local communities where they are located through jobs and wages, regional sales and production, and contracts (expenditures). Benefits include employment opportunities and increases in local business revenue, property sales, and tax revenue. The military creates a stable and consistent source of revenue for surrounding communities. Working to achieve compatibility with local development and activities with NASWI's mission continues to ensure the viability of the installation into the future and its positive impact on the local communities and the surrounding region.

As discussed in the Growler EIS, NASWI is a major contributor to the regional economy of Island County and neighboring Skagit County. The installation employs a combined workforce of over 9,000 military and civilian personnel, with direct annual payroll expenditures totaling $548 million. In total, NASWI contributed a $1.04 billion economic impact and supported approximately 13,000 jobs (direct and indirect) in Island and Skagit counties in Fiscal Year 2017 (Navy 2018[b]). In addition to economic impacts resulting from employment and spending at NASWI, the installation generates other community benefits, including the benefits provided to veterans in the region, federal impact aid dollars for local schools, and community involvement and partnership activities (Navy 2018[b]).

Ault Field is located in the unincorporated area of Island County, just outside of the city of Oak Harbor, and has been a primary driver of population growth in the city. Oak Harbor is the largest city in the county and had a population of 22,075 recorded in the 2010 census (U.S. Census Bureau n.d.[d]). City government estimates that Oak Harbor's population will grow by approximately 17 percent by 2036, to 25,814 people (City of Oak Harbor 2016). A portion of this population growth is expected to result from the recent squadron changes at NASWI discussed in this AICUZ Study (see Section 2.2.2, Projected Activities). The town of Coupeville, the county seat of Island County, had a population of 1,831 people in 2010 (U.S. Census Bureau n.d.[d]). According to the 2016 Island County comprehensive plan update, the population of the town of Coupeville is expected to increase by approximately 149 people by 2036 (Island County 2016[a]).

Island County, a largely rural county in the northern Puget Sound, had a total population of 78,506 people in 2010. Most population growth in the county has historically occurred in the northern part of the county, primarily in Oak Harbor (Island County 2016[a]). The County's population is projected to grow by approximately 7 percent each decade between 2010 and 2030, to almost 90,000 people in 2030 (Washington Office of Financial Management 2017). This is less than the projected rate of growth for neighboring Skagit County and the state of Washington. Island County's growth rate has been declining steadily since 1980. Growth in the county is largely driven by in-migration of working-age people who commute to jobs on the mainland; however, the increasing costs of commuting along with transportation capacity constraints and changing home-buyer preferences are expected to affect in-migration to the county. Retirees are expected to continue to move to the county; however, the rate of increase resulting from this trend is uncertain (Island County 2016[a]).

Skagit County had a population of 116,901 people in 2010. Skagit County is expected to grow by approximately 12 percent each decade between 2010 and 2030, to approximately 147,000 people in 2030 (Washington Office of Financial Management 2017). The Skagit County government anticipates that the moderate population growth expected in the county can be accommodated in the county's cities and towns and their urban growth areas (Skagit County 2016).

The state of Washington's population is projected to grow at a greater rate than the population of Island County. Washington's population was projected to grow by nearly 14 percent between 2010 and 2020, with population growth slowing to approximately 12 percent between 2020 and 2030, closer to Skagit County's projected rate of growth. Most of the state's population growth is projected to result from net migration rather than natural increase (the number of births compared to the number of deaths) as the population overall begins to age (Washington Office of Financial Management 2019[a]).

Table 2-1 provides population data and growth projections (where available) for the city of Oak Harbor, town of Coupeville, Island and Skagit counties, and the state of Washington.

TABLE 2-1 REGIONAL POPULATION ESTIMATES AND PROJECTIONS

POPULATION AREA	2000[a]	2010[b]	2020[c]	2030[c]	% GROWTH 2010-2020	% GROWTH 2020-2030
Island County	71,558	78,506	84,044	89,848	7.1	6.9
City of Oak Harbor	19,795	22,075	N/A	N/A	N/A	N/A
Town of Coupeville	1,723	1,831	N/A	N/A	N/A	N/A
Skagit County	102,979	116,901	130,705	146,880	11.8	12.4
State of Washington	5,894,121	6,724,540	7,659,446	8,606,369	13.9	12.4

Sources:
(a) U.S. Census Bureau n.d.[a], n.d.[b], n.d.[c]
(b) U.S. Census Bureau n.d.[d]; Washington Office of Financial Management 2019[a], 2019[b], 2017
(c) Washington Office of Financial Management 2019[a], 2017

Key:
N/A = Not available

3

3.1 Aircraft Types that Operate at NAS Whidbey Island

3.2 Aircraft Operations at NAS Whidbey Island

AIRCRAFT OPERATIONS

This chapter of the AICUZ Study discusses aircraft types and aircraft operations at NASWI, including based and transient aircraft, as well as preflight and maintenance operations, flight operations, annual operations, flight track use, operational modifications, and OLF Coupeville operations.

3.1 AIRCRAFT TYPES THAT OPERATE AT NASWI

This AICUZ Study discusses two types of aircraft: fixed-wing and rotary-wing. Fixed-wing aircraft include turbine (jet) and propeller-driven aircraft and generate lift by forward motion through the air. Rotary-wing aircraft, commonly called helicopters, generate lift by wing motion relative to the aircraft.

Aircraft that operate at NASWI are either based or transient. Based aircraft are permanently assigned at NASWI. Based aircraft use NASWI on a regular basis and are the most common aircraft conducting operations at and around the airfield and OLF Coupeville. Transient aircraft are all other aircraft not permanently based at NASWI. Transient aircraft conduct training or other mission-related operations at Ault Field or may only land briefly to refuel. Aircraft that are based at NASWI include the EA-18G Growler, P-8A Poseidon, EP-3 Aries II, C-40 Clipper, and MH-60S Seahawk. The transient aircraft that most frequently use NASWI include the C-40 Clipper and various Air Mobility Command (AMC) and AMC charter aircraft, including the C-17 and C-5, along with commercial 747 and 767.

This NASWI AICUZ Study accounts for changes in mission, aircraft, and operational levels once ongoing aircraft homebasing and transition actions are completed. As such, the analysis includes aircraft that are currently based and projected to operate at NASWI, as well as current transient aircraft operating at the installation. These ongoing actions are the same as those described in the *Environmental Impact Statement for EA-18G "Growler" Airfield Operations at Naval Air Station Whidbey Island Complex, WA* (Navy 2018[a]), including the expansion of EA-18G operations and transition of the P-3C to the P-8A. Based and transient aircraft that use Ault Field and OLF Coupeville are discussed below.

Nomenclature following the aircraft identifier often designates different models/series of the aircraft to identify changes to the aircraft or equipment. These differences are commonly called "variants" of the aircraft. For example, the EA-18G is a variant of the F/A-18F Super Hornet.

3.1.1 Based Aircraft

The based aircraft described in this section are associated with the aviation tenants described in Section 2.2, Mission and Installation Activities, and are the most common aircraft conducting operations at and around NASWI.

Fixed-Wing Aircraft

EA-18G Growler (Electronic Attack Wing Pacific and 390th Electronic Combat Squadron)

A variant of the F/A-18F Super Hornet, the EA-18G combines the combat capabilities of the Super Hornet with a cutting-edge avionics system. The EA-18G flies the tactical airborne electronic attack mission and is capable of countering enemy air defenses, jamming enemy communications, and serving in an escort role. The EA-18G is powered by two turbofan jet engines and accommodates a crew of two (NAVAIR n.d.[a]).

P-8A Poseidon (Patrol and Reconnaissance Wing 10)

The P-8A is a multi-mission maritime patrol fixed-wing aircraft capable of flying at altitudes of up to 41,000 feet and at speeds of 490 knots. The P-8A, based on the Boeing 737-800, is powered by two jet engines and can accommodate an air crew of nine. Capable of covering broad maritime and littoral areas, the P-8A is used for a wide variety of missions, including anti-submarine warfare; anti-surface warfare; intelligence, surveillance, and reconnaissance; and SAR (NAVAIR n.d.[b]).

EA-18G Growler

P-8A Poseidon

EP-3E Aries II (Patrol & Reconnaissance Wing 10)

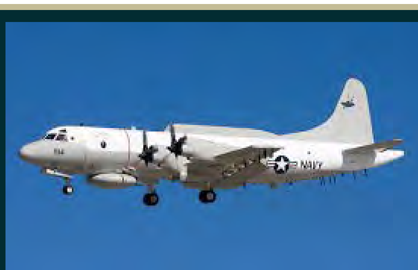
The EP-3E Aries II is a multi-intelligence reconnaissance aircraft based on the P-3 Orion airframe. It is the Navy's only land-based reconnaissance aircraft, powered by four turbo-prop engines and capable of reaching speeds of 411 knots and altitudes of 28,000 feet. With its range of sensitive receivers and high-gain dish antennas, the EP-3E is capable of providing fleet and theater commanders with near real-time tactical intelligence for direct threat warning, indications and warnings, information dominance, battle space situational awareness, suppression of enemy air defenses, destruction of enemy air-defense, anti-air warfare, and anti-submarine warfare applications (NAVAIR n.d.[c]).

C-40 Clipper (VR-61)

The C-40 Clipper provides critical logistics support to Navy fleet forces. The C-40, developed based on the Boeing 737-700C commercial airliner, is a medium-lift aircraft used for long-range, essential airlift missions and is capable of transporting both cargo and passengers. It is powered by two jet engines and can reach speeds of 534 knots and an altitude of 41,000 feet (NAVAIR n.d.[d]).

MH-60S Seahawk (NASWI Search and Rescue)

The MH-60S Seahawk is a twin-engine helicopter used at NASWI for SAR. It is equipped with a rescue hoist with a 250-foot cable capable of lifting 600 pounds, and a cargo hook with a 6,000-pound capacity. The MH-60S has a maximum speed of 180 knots and a range of about 380 nm (Navy 2019).


EP-3E Aries II


C-40 Clipper (VR-61)


MH-60S Seahawk

3.1.2 Transient Aircraft

The most common transient aircraft using Ault Field, including [add information on general types such as small turbo-prop passenger planes and single prop passenger planes, and large jet or cargo aircraft] are described below. In addition to the aircraft listed in this section, transient C-40 aircraft also use Ault Field. The C-40 is described in Section 3.1.1, Based Aircraft. Other transient aircraft that use Ault Field include the C-17, C-5M, 747, and 767.

C-17 Globemaster III

The C-17 Globemaster III is a cargo and personnel transport aircraft capable of rapid strategic delivery of personnel and all types of cargo to main operating bases or forward bases. The C-17 is used for tactical airlift and airdrop missions and for transport of patients during aeromedical evacuations. The C-17 is capable of transporting a cargo load of 164,900 pounds (approximately 82 tons) over a range of 2,400 nm (Air Force 2018[a]).

C-5M Super Galaxy

The C-5, the largest aircraft in the Air Force's inventory, is a strategic transport aircraft used to transport cargo and personnel. The Air Force currently operates the C-5M, a modernized version of the legacy C-5. The C-5M is capable of transporting a payload of up to 281,001 pounds (approximately 140 tons) over intercontinental ranges, can be refueled in the air, and can take off and land on relatively short runways (Air Force 2018[b]).

Boeing 747

Modified Boeing 747 aircraft are used by the DOD for cargo and passenger transport. The Boeing 747 is capable of flying a range of 7,730 nm (Boeing 2020[a]).

Boeing 767

The Boeing 767 is capable of carrying a payload of up to approximately 52,480 pounds (approximately 26 tons) over a range of about 3,255 nm (Boeing 2020[b]). The military variant of the aircraft is used for aerial refueling and strategic transport.

C-5 Galaxy

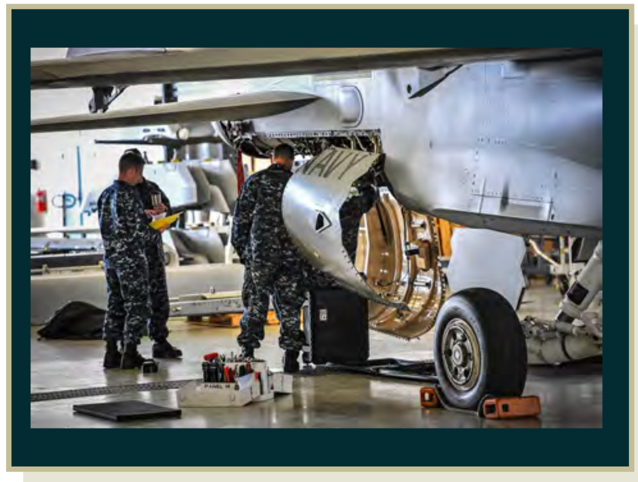
C-17 Globemaster III

3.2 Aircraft Operations at NASWI

A primary function of an AICUZ Study is to present noise contours and APZs for an airfield. The foundation for development of both noise contours and APZs is aircraft operations. "Aircraft operation" is a term that describes the pre-flight and flying activities of an aircraft. These activities make up the two primary sources of aircraft noise at NASWI: pre-flight and maintenance operations, and flight operations. The level of noise exposure from an aircraft operation is related to the aircraft type, engine power setting, altitude flown, direction of the aircraft, duration of run-up, flight track, temperature, relative humidity, frequency, and time of operation.

3.2.1 Pre-Flight and Engine Maintenance Operations

"Pre-flight run-ups" refer to aircraft engine checks conducted immediately prior to takeoff. Pre-flight run-ups are conducted on the runway ends or within designated areas. To perform various tests or repairs, run-ups are also conducted when an aircraft is parked on the ground and the engine is running. Engine maintenance run-up operations (i.e., aircraft engine maintenance operations) are conducted at seven locations: five low-power testing locations along the flight line and two high-power testing locations just west of Runway 14/32 and south of Runway 7/25. Engine maintenance activities include engine rinses and washes, maintenance turns, and high-power turns. Sometimes the engine may be removed from the aircraft and placed on an engine stand. Pre-flight and engine maintenance run-up locations are depicted on Figure 3-1. Over time, pre-flight and engine maintenance run-up locations have adapted to accommodate a variety of aircraft, to include new aircraft operating at NASWI. The noise associated with pre-flight and engine maintenance run-ups was included in the noise analysis and in the modeling associated with the 2005 and 2021 AICUZ noise contours, and is discussed in detail in Section 4.2, NASWI Airfield Noise Sources and Noise Modeling. No pre-flight or engine maintenance run-up operations are conducted at OLF Coupeville.



3.2.2 Flight Operations

A flight operation refers to any occurrence of an aircraft taking off or landing on the runway at an airfield. A common example of a takeoff operation is a departure of an aircraft to another location; a landing operation is an aircraft arrival from another location to the airfield. Additionally, a takeoff and landing may be part of a training maneuver or pattern (e.g., touch-and-go), which includes a takeoff and landing back to the same runway. These patterns are considered two operations because the departure and arrival each count as one operation. Typical flight operations at Ault Field and OLF Coupeville are described below and depicted on Figures 3-2 and 3-3.

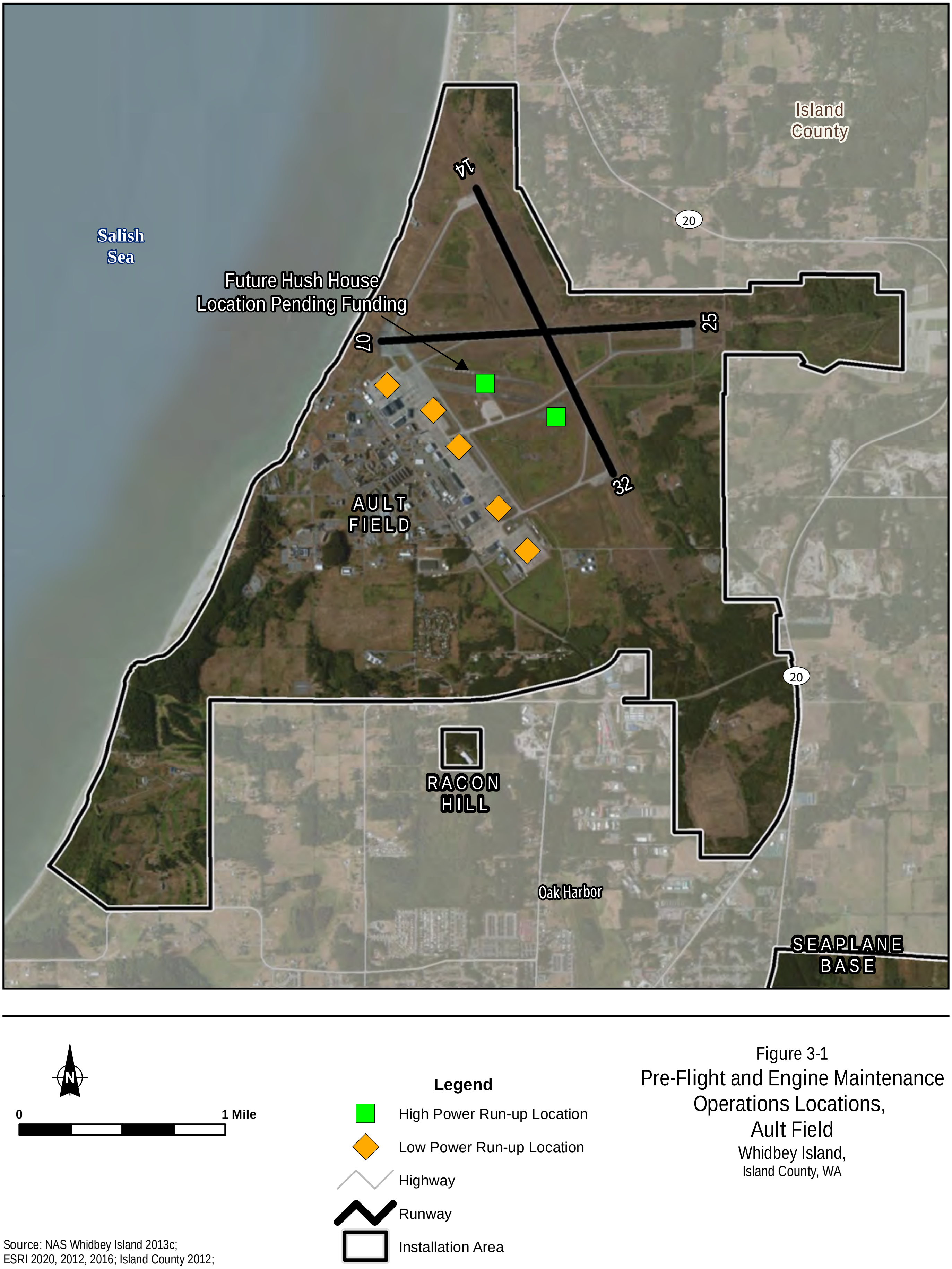


Figure 3-1
Pre-Flight and Engine Maintenance Operations Locations, Ault Field
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2013c;
ESRI 2020, 2012, 2016; Island County 2012;
Washington State Department of Ecology 2014.

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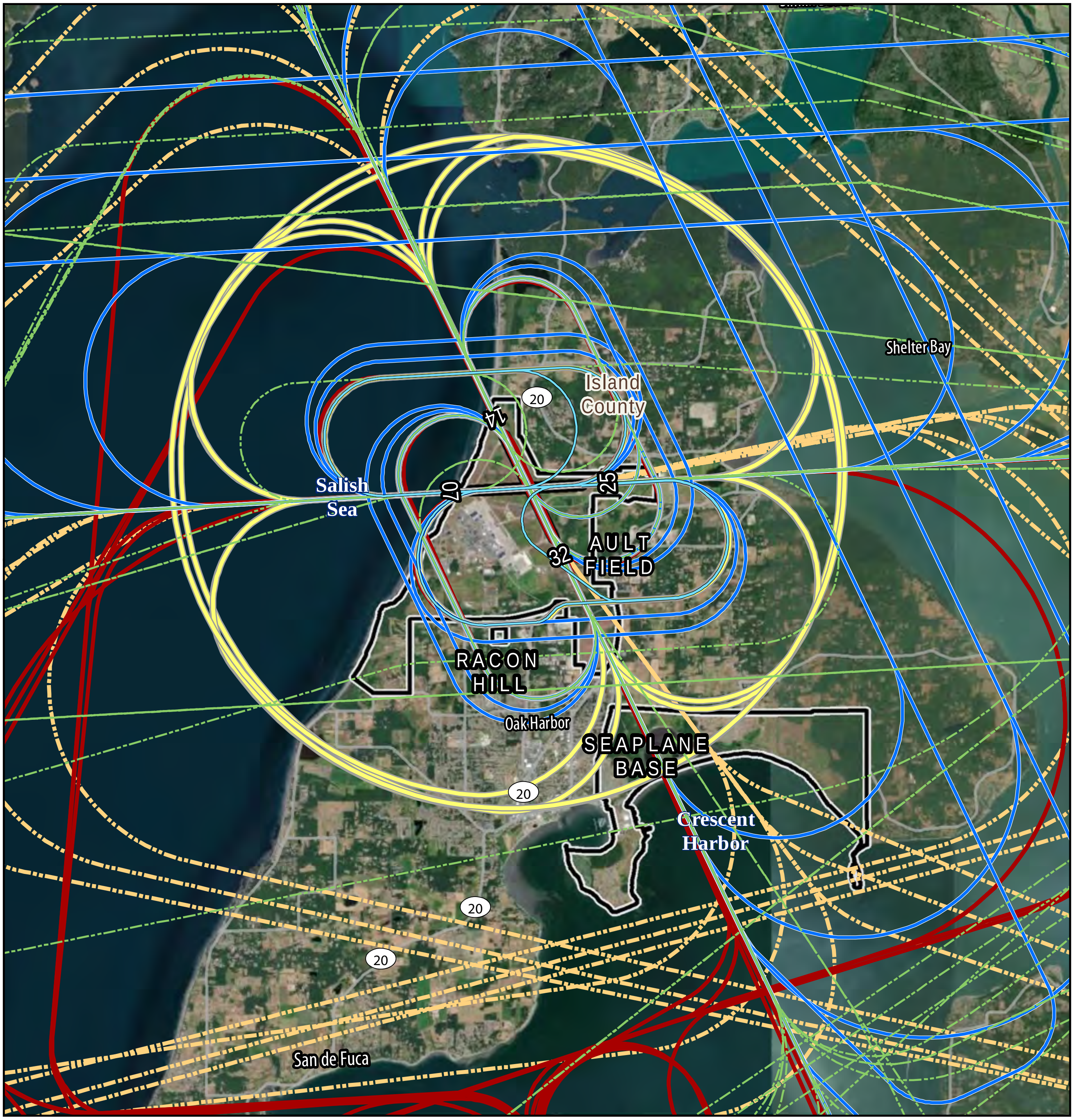

Figure 3-2
Representative Flight Tracks, Ault Field
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2013c; ESRI 2020, 2012, 2016; Island County 2012.

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Figure 3-3
Representative Flight Tracks,
OLF Coupeville
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020c; ESRI 2020, 2016;
Island County 2012; Ecology and Environment, Inc. 2020.

- Departure. An aircraft takes off to leave the installation or as part of a training maneuver.
- Arrival. An aircraft lands on the runway after returning from a local or non-local training range, or as part of a training maneuver (e.g., the arrival part of a touch-and-go maneuver). The three basic types of arrivals are:
    - Straight-In/Full-Stop Arrival. An aircraft lines up on the runway centerline several miles away from the airfield, descends gradually, lands, comes to a full stop, and then taxis off the runway.
    - Overhead Break Arrival. An expeditious arrival using VFR where an aircraft approaches the runway at altitude above the ground. Approximately halfway down the runway, the aircraft performs a 180-degree turn to enter the landing pattern. Once established in the pattern, the aircraft performs a second 180-degree, descending turn to land on the runway.
    - Approach (Instrumented). An aircraft approach, conducted under both IFR (i.e., when aircraft are flown referring only to the aircraft instrument panel for navigation) and VFR conditions, providing realistic training for both Navy aircrews and air traffic controllers.
- Pattern Operation. A pattern operation refers to traffic pattern training where the pilot performs arrivals and departures in quick succession by taking off, flying the pattern, and then landing. Traffic pattern training is demanding and utilizes all the basic flying maneuvers a pilot learns: takeoffs, climbs, turns, climbing turns, descents, descending turns, and straight and level landings. Most patterns have a left-handed orientation (counter clockwise, as viewed from above), which mimics how pilots fly on an aircraft carrier at sea. Each pattern is considered two operations: the landing or approach is counted as one operation, and the takeoff is counted as another.

  Types of pattern operations include:

    - Touch-and-Go. An aircraft lands and takes off on a runway without coming to a full stop. After touching down, the pilot immediately goes to full power and takes off again.
    - Field Carrier Landing Practice. FCLP is the required flight training that immediately precedes (and qualifies) aircrews for carrier-landing operations. These operations are conducted on a runway that simulates an aircraft carrier flight deck. FCLP is generally flown in a left-hand, closed-loop racetrack-shaped pattern, ending with a touch-and-go landing or a low approach with the Landing Signal Officer present and grading the proficiency of the pilot. The pattern should simulate, as closely as practicable, the conditions aircrews would encounter during actual carrier landing operations at sea.

- Ground Control Approach (GCA)/Carrier Controlled Approach (CCA). An aircraft lands with guidance from ground-based air traffic controllers to practice and conduct arrivals under actual or simulated adverse-weather conditions. Air traffic controllers provide aircrews with verbal course and elevation information, allowing them to make an instrument landing during IFR conditions. GCA training is conducted in both IFR and VFR conditions to provide realistic training for both Navy aircrews and air traffic controllers. CCA training is similar to GCA, but with the Landing Signal Officer present.

- Interfacility Operation. Specific flight tracks between the main airfield and outlying facilities. These flight patterns are generally short duration and serve to connect the departure, arrival, and pattern operations of the various installations or training areas.

Each airfield has designated runways with designated flight procedures that provide for the safety, consistency, and control of an airfield. A flight track is a route an aircraft follows while conducting an operation at the airfield, between airfields, or to/from a MOA, and demonstrates how the aircraft will fly in relation to the airfield.

Flight tracks are graphically represented as single lines, but how closely an aircraft flies to the specified track can vary due to aircraft performance, pilot technique, and weather conditions, such that the actual flight track could be considered a band or corridor varying from a few hundred feet to several miles wide. Flight tracks are typical or average representations based on pilot and ATC input. Figures 3-2 and 3-3 depict a representative flight track for each of the operations described above, and flight tracks are further discussed in Section 3.2.3, Annual Operations.

3.2.3 Annual Operations

"Annual operations" describe all aircraft operations that occur at NASWI during a calendar year, including operations by based and transient aircraft. As described above, total annual operations account for each arrival and departure, including those conducted as part of a pattern operation. Aircraft operations are tracked using systems maintained by ATC personnel. Data for 2021 operations were adopted from the 2018 *Environmental Impact Statement for EA-18G "Growler" Airfield Operations at Naval Air Station Whidbey Island Complex, WA* preferred alternative and the Record of Decision, dated March 19, 2019.

For the purposes of this AICUZ Study, and to develop noise contours and APZs, annual operations are further detailed by the following factors:

- Aircraft conducting the operation;
- Identified as based or transient;
- Squadron the aircraft is assigned to;
- Time of day the operation is conducted;
- Operation performed;
- Runway the operation is conducted on
- Number of operations performed; and
- Flight track flown to conduct the operation.

These factors all have differing effects on noise contours and APZs and influence the changes in the AICUZ footprint from 2005 to 2021. Additional parameters, such as altitude, power setting, and speed, are collected and considered for the noise modeling analysis and are discussed in Chapter 4, Aircraft Noise.

2005 AICUZ Study Projected Operations

The 82,107 annual operations are attributed to the variety of missions and based aircraft that were projected to operate out of Ault Field and OLF Coupeville in the 2005 AICUZ, including the EA-18G and P-3C, which accounted for the majority of operations by based aircraft. Over 99 percent of annual operations at Ault Field and OLF Coupeville were from based aircraft; less than 1 percent were attributed to transient aircraft operations (Table 3-1). Pattern operations were performed most frequently, representing 67 percent of all operations, or 55,412 annual operations. The majority (90 percent) of all operations were conducted during acoustic daytime hours (7:00 a.m. to 10:00 p.m.), 10 percent were conducted during acoustic nighttime hours (10:00 p.m. to 7:00 a.m.).

2021 AICUZ Study Projected Operations

This AICUZ Study provides analysis for and incorporates known and anticipated changes in mission and operations, as analyzed in the 2018 Growler EIS. Based on the changes described in the EIS, the Navy forecasts that total annual operations at NASWI will increase when compared to 2005 AICUZ annual operations. As shown in Table 3-2, annual operations in will increase to 112,100, with 88,000 operations at Ault Field and 24,100 operations at OLF Coupeville. Most operations (85 percent) will occur during acoustic daytime hours (7:00 a.m. to 10:00 p.m.).

Expansion of existing EA-18G operations at NASWI and the addition of 36 aircraft are the primary factors causing the increase in total annual operations, compared to 2005 conditions. Operations are expected to increase at the OLF, from 6,120 operations in 2005 to 24,100 operations. Due to the increase at OLF Coupeville, in part, pattern operations at Ault Field are projected to decrease from the 2005 to this 2021 AICUZ operations.

The increase in EA-18G aircraft also factors into an increase in arrivals and departures at Ault Field from the 2005 to this 2021 AICUZ. This 2021 AICUZ includes interfacility operations for both Ault Field and OLF Coupeville, including operations to and from the OLF. Interfacility operations were not included as a separate operational type in the 2005 AICUZ.

The operations include a mix of aircraft, both based and transient, conducting various operation types at NASWI.

TABLE 3-1 2005 AICUZ ANNUAL OPERATIONS

	GROUP	AIRCRAFT	DEPARTURE			ARRIVALS (STRAIGHT-IN, OVERHEAD BREAK, CARRIER BREAK)			PATTERNS (TOUCH-AND-GO, GCA, FCLP)			TOTAL ANNUAL OPERATIONS		
			ACOUSTIC DAY	ACOUSTIC NIGHT	TOTAL	ACOUSTIC DAY	ACOUSTIC NIGHT	TOTAL	ACOUSTIC DAY	ACOUSTIC NIGHT	TOTAL	ACOUSTIC DAY	ACOUSTIC NIGHT	TOTAL
	Ault Field													
Based	Military	EA-18G, P-3, C-9	12,423	673	13,096	12,404	692	13,096	43,539	5,753	49,292	68,365	7,118	75,483
Based	**Based Totals**		**12,423**	**673**	**13,096**	**12,404**	**692**	**13,096**	**43,539**	**5,753**	**49,292**	**68,365**	**7,118**	**75,483**
Transient	All Aircraft Types	Transient	164	88	252	164	88	252	-	-	-	328	176	504
Transient	**Transient Totals**		**164**	**88**	**252**	**164**	**88**	**252**	**-**	**-**	**-**	**328**	**176**	**504**
	Ault Field Totals		**12,587**	**761**	**13,348**	**12,568**	**780**	**13,348**	**43,539**	**5,753**	**49,292**	**68,693**	**7,294**	**75,987**
	OLF Coupeville													
	Military	EA-18G	-	-	-	-	-	-	5,091	1,029	6,120	5,091	1,029	6,120
	OLF Coupeville Totals		**-**	**-**	**-**	**-**	**-**	**-**	**5,091**	**1,029**	**6,120**	**5,091**	**1,029**	**6,120**
	Grand Totals		**12,587**	**761**	**13,348**	**12,568**	**780**	**13,348**	**48,630**	**6,782**	**55,412**	**73,784**	**8,323**	**82,107**

Source:
NAVFAC Southwest 2005

Notes:
Acoustic daytime hours are from 7:00 a.m. to 10:00 p.m.
Acoustic nighttime hours are from 10:00 p.m. to 7:00 a.m.

Key:
GCA = Ground Control Approach
FCLP = Field Carrier Landing Practice

TABLE 3-2 2021 AICUZ ANNUAL OPERATIONS

GROUP		AIRCRAFT	DEPARTURE			ARRIVALS (STRAIGHT-IN, OVERHEAD BREAK, CARRIER BREAK)			PATTERNS (TOUCH-AND-GO, GCA, FCLP)			INTERFACILITY			TOTAL ANNUAL OPERATIONS		
			ACOUSTIC DAY	ACOUSTIC NIGHT	TOTAL	ACOUSTIC DAY	ACOUSTIC NIGHT	TOTAL	ACOUSTIC DAY	ACOUSTIC NIGHT	TOTAL	ACOUSTIC DAY	ACOUSTIC NIGHT	TOTAL	ACOUSTIC DAY	ACOUSTIC NIGHT	TOTAL
	Ault Field																
Based	Military	EA-18G, EP-3E, P-8A, MH-60S, C-40	19,110	1,120	20,230	18,530	1,700	20,230	35,290	8,070	43,360	2,530	610	3,140	75,470	11,500	86,970
	Based Totals		**19,110**	**1,120**	**20,230**	**18,530**	**1,700**	**20,230**	**35,290**	**8,070**	**43,360**	**2,530**	**610**	**3,140**	**75,470**	**11,500**	**86,970**
Transient	All Aircraft Types	Transient	415	100	515	415	100	515	-	-	-	-	-	-	830	200	1030
	Transient Totals		**415**	**100**	**515**	**415**	**100**	**515**	**-**	**-**	**-**	**-**	**-**	**-**	**830**	**200**	**1,030**
	Ault Field Totals		**19,525**	**1,220**	**20,745**	**18,945**	**1,800**	**20,745**	**35,290**	**8,070**	**43,360**	**2,530**	**610**	**3,140**	**76,300**	**11,700**	**88,000**
	OLF Coupeville																
	Military	EA-18G, MH-60S	-	-	-	-	-	-	2,530	610	3,140	16,750	4,190	20,940	19,300	4,800	24,100
	OLF Coupeville Totals		**-**	**-**	**-**	**-**	**-**	**-**	**2,530**	**610**	**3,140**	**16,750**	**4,190**	**20,940**	**19,300**	**4,800**	**24,100**
Grand Totals			**19,525**	**1,220**	**20,745**	**18,945**	**1,800**	**20,745**	**37,820**	**8,680**	**46,500**	**19,280**	**4,800**	**24,080**	**95,600**	**16,500**	**112,100**

Source:
Navy 2018[a]

Notes:
Three-digit numbers are rounded to nearest 100 if ≥ to 100; two-digit numbers are rounded to the nearest 10 if ≥ 10 or if between 1 and 9.
Acoustic daytime hours are from 7:00 a.m. to 10:00 p.m.
Acoustic nighttime hours are from 10:00 p.m. to 7:00 a.m.

Key:
GCA = Ground Control Approach
FCLP = Field Carrier Landing Practice

3.2.4 Runway and Flight Track Utilization

As discussed in Section 3.2.2, Flight Operations, and depicted on Figures 3-2 and 3-3, flight tracks are the general paths aircraft fly while conducting missions or operations. The following factors determine flight track utilization: operation performed, runway utilized for the operation, and flight track followed to conduct the operation.

The frequency with which a runway is used by different aircraft types is determined by a variety of factors, including runway length, winds, location of airfield features (e.g., lights, arresting gear), number of aircraft in the pattern, or the preference of a runway for noise abatement or safety concerns (e.g., birds). Runway use at NASWI is determined by the Air Operations (Air Ops) Manual, which the Air Ops Officer maintains. The Air Ops Manual sets the course rules for the airfield and establishes the patterns and procedures for aircraft movement. All aircraft operating at NASWI follow the course rules in the Air Ops Manual.

The change in runway utilization from 2005 to 2021 is shown in Tables 3-3 and 3-4. Runway utilization varies significantly by aircraft type, although Runways 25 and 14 at Ault Field and Runway 32 at OLF Coupeville are the primary runways utilized in 2021. As noted in Section 2.3.2, OLF Coupeville, based on historical meteorological conditions at OLF Coupeville, runway utilization for Runway 32 is approximately 70 percent of operations and Runway 14 is used for approximately 30 percent of operations.

TABLE 3-3 CHANGES IN RUNWAY UTILIZATION, AULT FIELD

RUNWAY	PERCENT UTILIZATION	
	2005[a]	2021[b]
07	20	16
25	49	46
14	27	32
32	4	6

Sources:
(a) NAVFAC Southwest 2005
(b) Navy 2018[a]

TABLE 3-4 CHANGES IN RUNWAY UTILIZATION, OLF COUPEVILLE

RUNWAY	PERCENT UTILIZATION	
	2005[a]	2021[b]
14	50	30
32	50	70

Sources:
(a) Wyle Laboratories, Inc. 2004
(b) Navy 2018[a]

Flight tracks are nominal representations of an aircraft's typical route and demonstrate how and where aircraft fly in relation to an airfield. Flight tracks provide safety, consistency, and control of an airfield. Flight tracks are bands, often a few hundred feet to several miles wide. The flight tracks and utilization data collected as part of this AICUZ Study inform the flight frequency concentrations of aircraft flights for 2021. The effect of flight track utilization on noise contours is presented in Chapter 4, Aircraft Noise; the association between flight tracks and APZs is included in Chapter 5, Airfield Safety. Representative flight tracks for Ault Field and OLF Coupeville are shown on Figures 3-2 and 3-3.

3.2.5 Operational Procedures

NASWI Air Ops and the FAA provide rules that all aircraft are required to follow when utilizing controlled airspace and the airfield. The course rules establish control and safety by providing procedures that account for aircraft separation, traffic patterns for runway in use, arrivals/departures, noise abatement, altitudes and airspeed, allowable weather conditions, and aircraft emergencies. As such, aviators performing operations at NASWI follow established rules and procedures while operating at the airfield. Likewise, aviators perform operations at specific altitudes, airspeeds, power settings, and follow set flight tracks to operate the aircraft at peak performance and to train for operations conducted at sea. Aircraft operating procedures are performed according to OPNAVINST 3710.7, Naval Air Training and Operating Procedures Standardization (NATOPS) General Flight and Operating Instruction. NATOPS are published for the purpose of standardizing ground and flight procedures. The purpose of the NATOPS Program is to increase combat readiness and improve flight safety. Limitations or restrictions on performing such operations pose a risk to pilots and the mission at NASWI.

NASWI course rules are updated in response to changes in mission and safety hazards and to reduce noise exposure and safety risks, some of which are operational modifications. The following course rules are operational modifications that have been implemented and have, subsequently, reduced off-base noise exposure and safety risks:

- Aircraft remain gear up on straight in approach until south of Lopez Island when able.
- NASWI operators adhere to noise abatement procedures, discussed in detail in Section 4.3.1, Noise Abatement.

NASWI is committed to the health, safety, and welfare of the local community, and considers operational modifications to reduce operational effects on the local community as they are identified; however, the capacity to implement operational modifications is limited by several factors, such as flight track restrictions, existing noise abatement mitigation, weather and operational demand. These factors consist of limitations or restrictions on flight tracks, altitudes, or runway usage, as described below:

- Runways 25 and 14 at Ault Field are the preferred runways for all normal operations due to prevailing winds and NASWI's noise abatement procedures.
- Runway 32 at OLF Coupeville is the preferred runway for all normal operations due to prevailing winds.
- Resident and migratory bird activity increases the potential for bird/animal aircraft strike hazard (BASH). To reduce this hazard, flight patterns are altered during times of increased bird activity.

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4 AIRCRAFT NOISE

4.1 Sound Measurements and Guidance
4.2 NAS Whidbey Island Noise Sources and Noise Modeling
4.3 Noise Abatement and Complaints
4.4 AICUZ Noise Contours

How an installation manages its aircraft noise plays a key role in the installation's relationship with neighboring communities. Aircraft noise is also a factor in local land use planning. Since noise from aircraft operations could affect areas near Ault Field and OLF Coupeville, the Navy has analyzed the noise resulting from its aircraft and has established noise exposure contours around the installation using the guidance provided in the AICUZ Instruction. Noise contours provide communities and planning organizations with information to better plan for compatible development near airfields. The noise contours developed for this AICUZ Study represent the noise generated by aircraft based on aircraft type, aircraft operations, and the time of day aircraft are flown.

This chapter discusses noise associated with aircraft operations, including average noise levels, noise abatement/flight procedures, noise complaints, sources of noise, airfield-specific noise contours, and discussion of changes from the 2005 AICUZ to the 2021 AICUZ noise contours. The 2021 AICUZ noise contours for NASWI are presented in the following sections along with detailed descriptions of the noise environments for the installation. Also provided are comparisons and figure overlays of the 2005 and 2021 AICUZ noise contours.

4.1 NOISE METRICS

Sound is vibrations in the air that can be generated by multiple sources. When sound is invasive or unwanted, it is often considered noise. Generally, sound becomes noise to a listener when it interferes with normal activities. Common sources of noise include roadway traffic, recreational activities, railway activities, and aircraft operations. For further discussion of noise and its effect on people and the environment, see Appendix A.

In this AICUZ Study, all sound or noise levels are in A-weighted decibels (dBA), which represent sound pressure adjusted to better represent human hearing response. Humans are most sensitive to sound frequencies within the range of human speech and less sensitive to lower and higher frequencies. The A-weighted scale emphasizes those mid-range frequencies while de-emphasizing the remaining frequencies.

For brevity, the adjective "A-weighted" is often omitted and the measurements are expressed as decibels (dB). On an A-weighted scale, barely audible sound is just above 0 dB, and normal speech has a sound level of approximately 60 to 65 dB. Generally, a sound level above 120 dB will cause discomfort to a listener (Berglund and Lindvall 1995), and the threshold of pain is 140 dB.

The noise exposure from aircraft at NASWI is calculated using the day-night average sound level (DNL) noise metric. The DNL noise metric, established in 1980 by the Federal Interagency Committee on Urban Noise, presents a reliable measure of community sensitivity to aircraft noise and has become the standard metric used in the United States. DNL averages the sound energy from aircraft operations at a location over a 24-hour period. DNL also adds an additional 10 dB to events occurring between 10:00 p.m. and 7:00 a.m. These decibel adjustments represent the added intrusiveness of sounds due to increased sensitivity to noise when ambient sound levels are low.

Typical A-Weighted Sound Levels and Common Sounds

- 0 dB – Threshold of Hearing
- 20 dB – Ticking Watch
- 45 dB – Bird Calls (distant)
- 60 dB – Normal Conversation
- 70 dB – Vacuum Cleaner (3 feet)
- 80 dB – Alarm Clock (2 feet)
- 90 dB – Motorcycle (25 feet)
- 100 dB – Ambulance Siren (100 feet)
- 110 dB – Chain Saw
- 120 dB – Rock Concert
- 130 dB – Jackhammer
- 140 dB – Threshold of Pain

DNL provides a single measure of overall noise exposure by combining disparate noise events (e.g., brief events with high noise levels, longer duration events at lower noise levels, and events occurring during different times of day which are more likely to disturb people in the community). Scientific studies and social surveys conducted to evaluate community annoyance with all types of environmental noise have found DNL to be the best measure available of community annoyance (FICUN 1980; FICON 1992). Although DNL provides a single measure of overall noise exposure, 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 DNL of 65 dBA could result from only a few noisy events or from a large number of quieter events.

DNL is depicted on a map as a noise contour that connects point of equal noise value. Contours are displayed in 5-dBA increments (i.e., 60, 65, 70, 75, 80, and 85 DNL). Noise levels inside a contour may be similar to those outside a contour line. Where the contour lines are close together, the change in noise level is greater. Where the lines are far apart, the change in noise level is more gradual. Calculated noise contours are discussed further in Section 4.4, AICUZ Noise Contours.

4.2 NASWI Airfield Noise Sources and Noise Modeling

In support of the 2018 Growler EIS, the Navy conducted a noise analysis. Data were collected from NASWI installation personnel, pilots, ATC, Air Ops, and squadron personnel, as well as from a range of resource documents (e.g., Air Traffic Activity Reports, Environmental Assessments, and other publications). Data sources are discussed in Section 3.2.3, Annual Operations. Data were compiled and input into computer models that graphically depict noise exposure as noise contours. The primary Navy-generated sources of noise at an airfield are aircraft flight operations and ground maintenance (run-ups). The inputs and data provided by the Navy and analyzed with the NOISEMAP software suite include:

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

This AICUZ uses the projected 2024 aircraft operational levels and noise contours of the Growler EIS Record of Decision as a reasonably foreseeable long-term planning projection for this AICUZ planning document. The noise contours are discussed further in Section 4.4, AICUZ Noise Contours.

4.3 Noise Abatement and Complaints

NASWI implements noise abatement measures, to the best of its ability, commensurate with safety and operational training requirements. Noise abatement procedures are implemented under the Air Ops Manual and are summarized below. The purpose of these procedures is to reduce community exposure to aircraft noise. However, because noise exposure from an active military installation cannot be completely minimized or avoided, NASWI has implemented a noise complaint program that ensures that community concerns are considered and addressed as explained below in Section 4.3.2.

4.3.1 Noise Abatement

NASWI minimizes aircraft noise in the community by implementing noise abatement or avoidance procedures with which all aviators are required to comply. Airfield procedures used to minimize or abate noise for operations conducted at Ault Field and OLF Coupeville include optimizing flight tracks and runway usage, restricting maintenance run-up hours, and other procedures as documented in the Air Ops Manual (NASWHIDBEYINST 3710.1AA). Additionally, air crews are directed, to the maximum extent practicable, to employ airmanship techniques to reduce aircraft noise effects on the community and to avoid sensitive areas except when safety dictates otherwise. The Navy cannot alter critical portions of flight patterns to accommodate noise complaints without increasing the risk to pilots; however, there are procedures in place to reduce noise exposure. Detailed information on noise abatement procedures implemented at NASWI are included in Appendix H to the 2018 Growler EIS, which is available online at: https://www.nepa.navy.mil/growler/EIS-Docs/.

NASWI personnel are active members in the communities surrounding the airfield and continuously engage with stakeholders to establish open communication and resolution of noise issues.

4.3.2 Noise Complaints

Noise complaints are related to the intensity and frequency of the events, as well as individual sensitivity. Complaints can arise outside the areas depicted by noise contours. This is frequently due to a single event that is unusual, such as when an aircraft flies over an area not commonly overflown or new aircraft begins operating in the region. In general, individual responses to noise levels vary, and are influenced by several factors including:

- The activity an individual was engaged in at the time of the noise event;
- The individual's general sensitivity to noise;
- The time of day or night;
- The length of time an individual is exposed to a noise;
- The predictability of noise; and
- Weather conditions.

Noise contours and land use recommendations are based on average annoyance responses of a population, but some people have greater noise sensitivity than others. Generally, a small increase in noise level will not be noticeable; however, as the change in noise level increases, individual perception becomes greater.

Noise complaints are received by Air Ops personnel and coordinated with the Commanding Officer, Executive Officer, Operations Officer, Air Traffic Control Officer, Public Affairs Office, and CPLO. Noise complaints are recorded according to date, time, and location of the event and the general nature of the complaint. When additional study is indicated, the complaint is mapped and Air Ops consults on what event occurred during the time and place of the complaint. When necessary, a follow-up call to the individual who initiated the complaint is made, and an explanation of the noise event is provided. The CPLO maintains a file of noise complaints for historic records and trend analysis.

Change in dB and 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 AICUZ NOISE CONTOURS

For land use planning purposes, the AICUZ Program divides noise exposure into three categories, known as "noise zones," based on DNL levels.

- Noise Zone 1: less than 65 DNL (< 64 dB DNL);
- Noise Zone 2: 65 to less than 75 DNL (65 to 74 dB DNL); and
- Noise Zone 3: Greater than or equal to 75 DNL (75 to 85+ dB DNL).

Land use recommendations within these zones are discussed and provided in Chapter 7, Land Use Compatibility Analysis and Recommendations.

Noise contours can be mapped to show noise exposure resulting from modeled aircraft operations. Noise contours, when overlaid with local land uses and zoning can assist NASWI, local community planning organizations, and citizens in locating and addressing incompatible land uses and in planning for future development.

At a minimum, DOD requires that contours be plotted for DNL values of 60, 65, 70, 75, and 80 in AICUZ studies. Contours less than 60 DNL can also be depicted to account for potential noise in lower ambient levels. For this AICUZ, the 55 DNL contour was plotted and included on the Chapter 4 figures to provide additional context on the noise exposure around NASWI. However, Noise Zone 1 (DNL less than 65) does not have recommended land use controls per the Navy's recommendations; therefore, contours less than 65 DNL were not included in acreage calculations in Chapter 4, Aircraft Noise, or the land use compatibility analysis in Chapter 7, Land Use Compatibility Analysis and Recommendations.

The noise contours provided in this AICUZ Study are identified as either 2005 or 2021. The 2021 noise contours capture the projected future condition to help ensure that any future airfield operations changes are accounted for. As a planning document, the AICUZ Study forecasts aircraft operations to assess future levels of noise exposure in the local community. Therefore, projected operations are incorporated into this 2021 AICUZ Study. The projected operations for NASWI are presented in Chapter 3, Aircraft Operations, and detailed in Tables 3-1 and 3-2.

The 2021 AICUZ noise contours for NASWI are presented in the following sections, along with detailed descriptions of the noise environment. Also provided are comparisons and figure overlays of the 2005 and 2021 contours. The comparison identifies changes to noise exposure (based on changes in aircraft operations) and allows the identification of incompatible land use and potential recommendations to reduce noise exposure. Land use and recommendations for addressing incompatibility issues within noise contours are provided and discussed in Chapter 7, Land Use Compatibility Analysis and Recommendations.

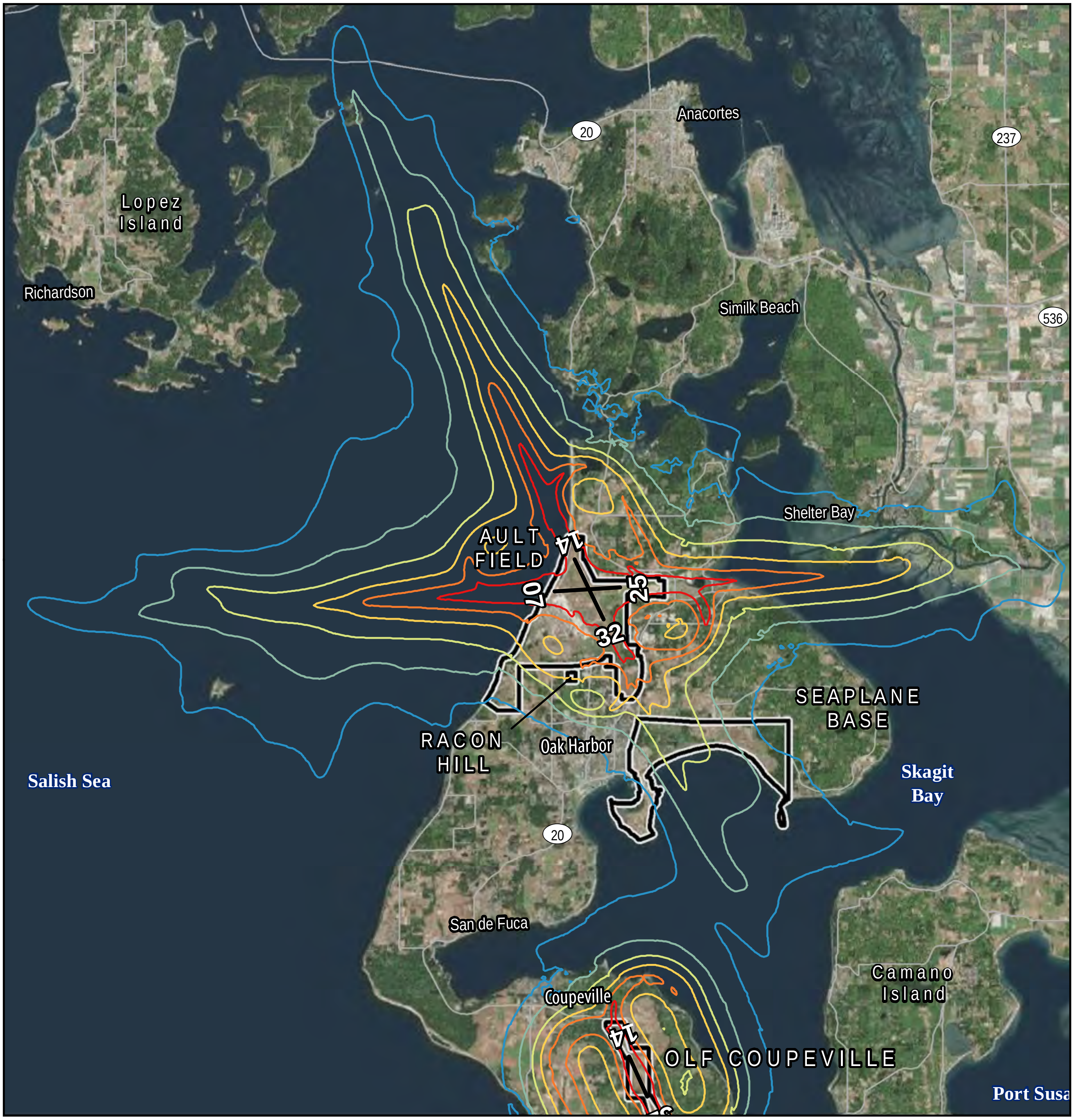
4.4.1 2021 Noise Contours

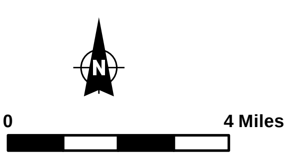
Ault Field

The 2021 AICUZ noise contours overlay the area in the immediate vicinity of the Ault Field and spread outward along aircraft flight tracks. The highest DNL noise contours are concentrated within or in the immediate vicinity of the installation boundary (Figure 4-1). The projected noise exposure primarily derives from EA-18G Growler flight operations.

West of Ault Field the noise contours follow the Runway 25 departure and Runway 07 arrival flight tracks out over the waters of the Salish Sea. North of Ault Field the 60-dB and 65-dB noise contours cover most of the land area up to Rosario Beach. The 70-dB, 75-dB, and 80-dB noise contours extend into portions of Island County north of the installation boundary. These contours are influenced by the Runway 32 departure and Runway 14 arrival flight tracks. East of Ault Field the noise contours extend along the Runway 07 departure and Runway 25 arrival flight tracks. Noise contours from 60 dB up to 85 dB overlay portions of Island County east of the installation. The 80-dB and 85-dB contours extend into Dugualla Bay and the 60-dB through 75-dB contours cross Dugualla Bay into Skagit County. South of the installation, along the Runway 14 departure and Runway 32 arrival flight tracks, portions of the 60-dB through 75-dB noise contours cover areas of Oak Harbor outside of the installation boundary. The 60-dB through 70-dB contours extend through the Seaplane Base and into the waters of Crescent Harbor (Figure 4-1).

The areas immediately east and south of Ault Field are exposed to noise levels up to 85 dB. The most utilized arrivals and departures from multiple runways (Runway 14 and 07 departure and Runway 32 and 25 arrival flight tracks) cause these elevated noise levels.





Legend

Highway		Noise Contour	
Runway			60 dB DNL
Installation Area			65 dB DNL
			70 dB DNL
			75 dB DNL
			80 dB DNL
			85 dB DNL

Figure 4-1
2021 AICUZ Noise Contours, Ault Field
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

OLF COUPEVILLE

The 2021 AICUZ noise contours overlay the area in the immediate vicinity of OLF Coupeville and spread outward along aircraft flight tracks. The FCLP patterns conducted by the EA-18G Growlers create elliptical noise contours that emanate out from the racetrack flight patterns primarily flown at OLF Coupeville (Figure 4-2).

The 85 dB noise contour is along the runway and continues along the flight track for a short distance in line with the Runway 32 and 14 arrivals. Due to the lower altitude of the FCLP flight tracks the noise contours (75 dB and 80 dB) follow the path of these flight tracks. The 80-dB contour primarily appears on the west side of OLF Coupeville along the Runway 32 FCLP flight track. It also overlays portions on the north and south along the Runway 14 FCLP. The 75-dB contour overlays both the east and west sides of the OLF following the Runway 14 and Runway 32 FCLP flight tracks. The 60-dB, 65-dB, and 70-dB noise contours encapsulate the Runway 32 and 14 FCLP flight patterns and extend outward. West of OLF Coupeville the Crockett Lake subdivision is exposed to average noise levels in excess of 75 dB and the 60-dB and 65-dB contours extend out to overlay the Fort Casey area and into the waters of Admiralty Inlet. To the north, the 60-dB and 65-dB contours reach the town of Coupeville and extend into the waters of Penn Cove. East of OLF Coupeville, the 75-dB contour and below reach the waters of Race Lagoon and Harrington Lagoon. On the south side of OLF Coupeville, the 80-dB and 85-dB contours overlay the Admirals Cove subdivision. The 60-dB and 65-dB contours extend over Ledgewood Beach and the 60 dB continues south to Teronda Beach (Figure 4-2).

Several areas around OLF Coupeville are exposed to elevated noise levels during training events. Specifically, the area just outside the northern installation boundary along State Route 20 and several communities to the east along the coast. To the south, the Admirals Cove subdivision and, to the west, the Crockett Lake subdivision, all are exposed to noise levels in excess of 75 dB.

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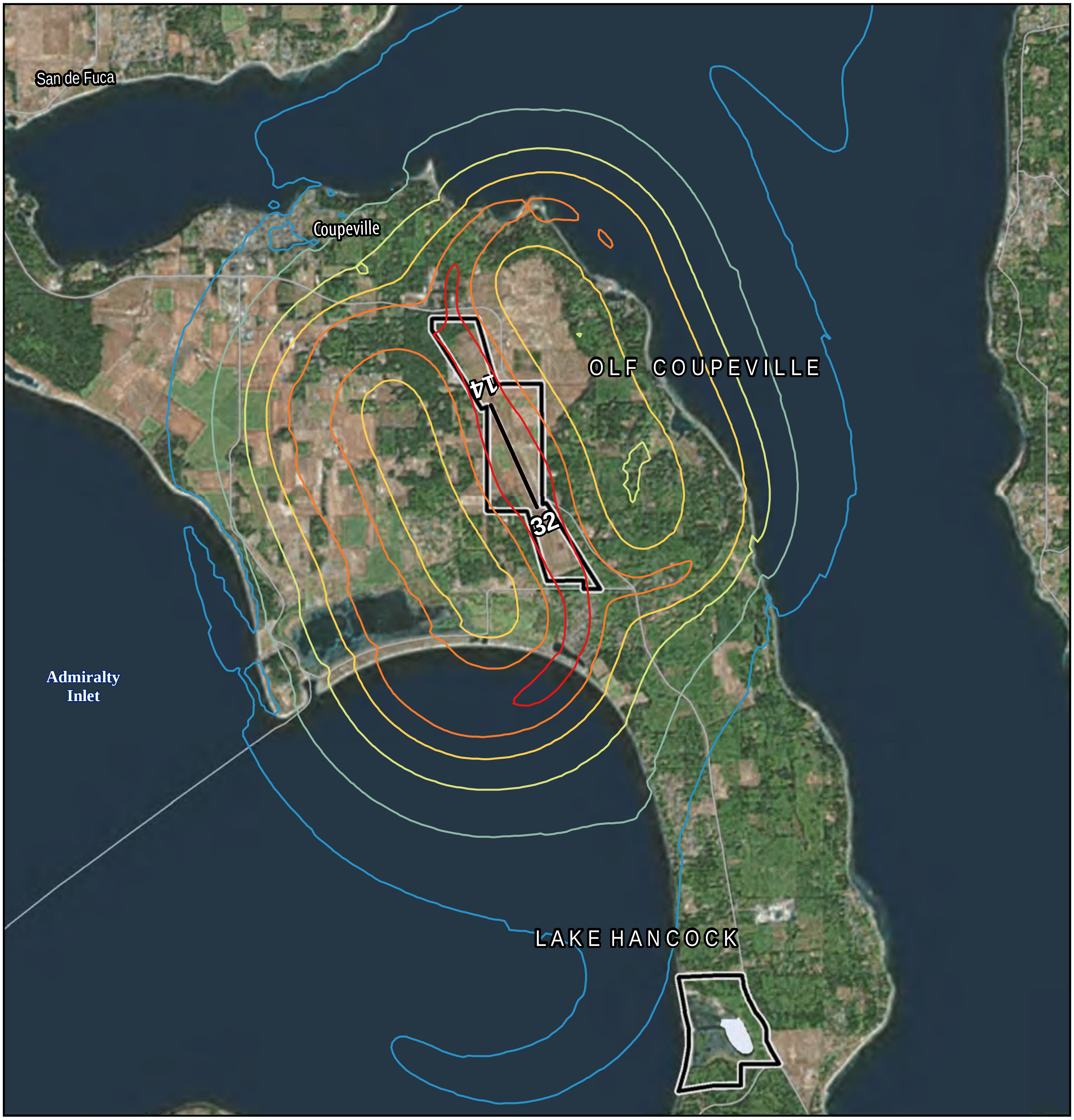

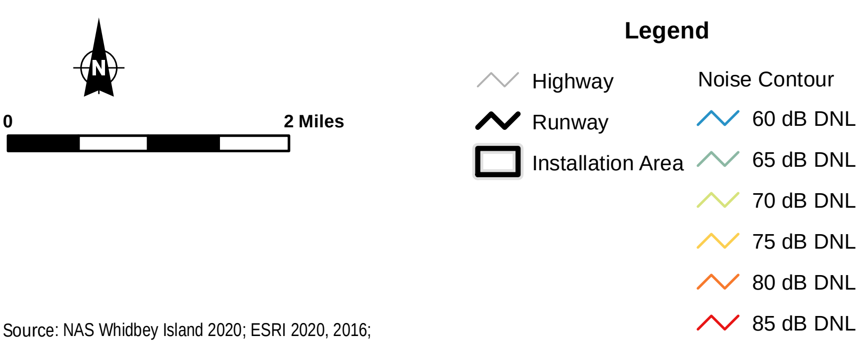

Figure 4-2
2021 AICUZ Noise Contours, OLF Coupeville
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

4.4.2 NOISE GRADIENT AND PROPAGATION

The ambient noise level (sometimes called background noise level) is the background sound level at a given location, normally specified as a reference level to the study. The noise gradient illustrated on Figures 4-2 and 4-3 ends at 55 dB DNL, because that is the general point in which the ambient noise becomes greater.

The sound associated with aircraft operations extends beyond the plotted DNL contours. Figures 4-3 and 4-4 provides a DNL color gradient that illustrates how the noise originating at Ault Field and OLF Coupeville dissipates into the surrounding communities. The sequence of sound waves propagates through the air. During the propagation, sound waves are reflected, refracted, and attenuated (i.e., weakened) by the density of the air. Therefore, the highest noise levels are concentrated at the source within the airfields and along flight paths and decrease to much lower levels with increased distance from these areas. Figures 4-2 and 4-3 also depict the noise outside the 65-dB DNL noise contour. The AICUZ Program does not recommend land use controls in these areas. The area within the 55-dB DNL represents an approximate location where dominant noise exposure sources may shift from aircraft to non-aircraft sources and the natural ambient noise levels that were not included in the noise study. Much of the lower DNL values result from aircraft at higher altitudes further from the ground or much less frequent aircraft flight activity than those within the 65-dB DNL contour. The FCLP pattern at OLF Coupeville and GCA/CCA box patterns, touch-and-go patterns, landing approaches, and FCLPs to Runways 32 and 25 at Ault Field generate most of the noise outside of the 65-dB DNL contour (most green shaded areas on Figures 4-3 and 4-4) due to the lower altitudes required for these operations.

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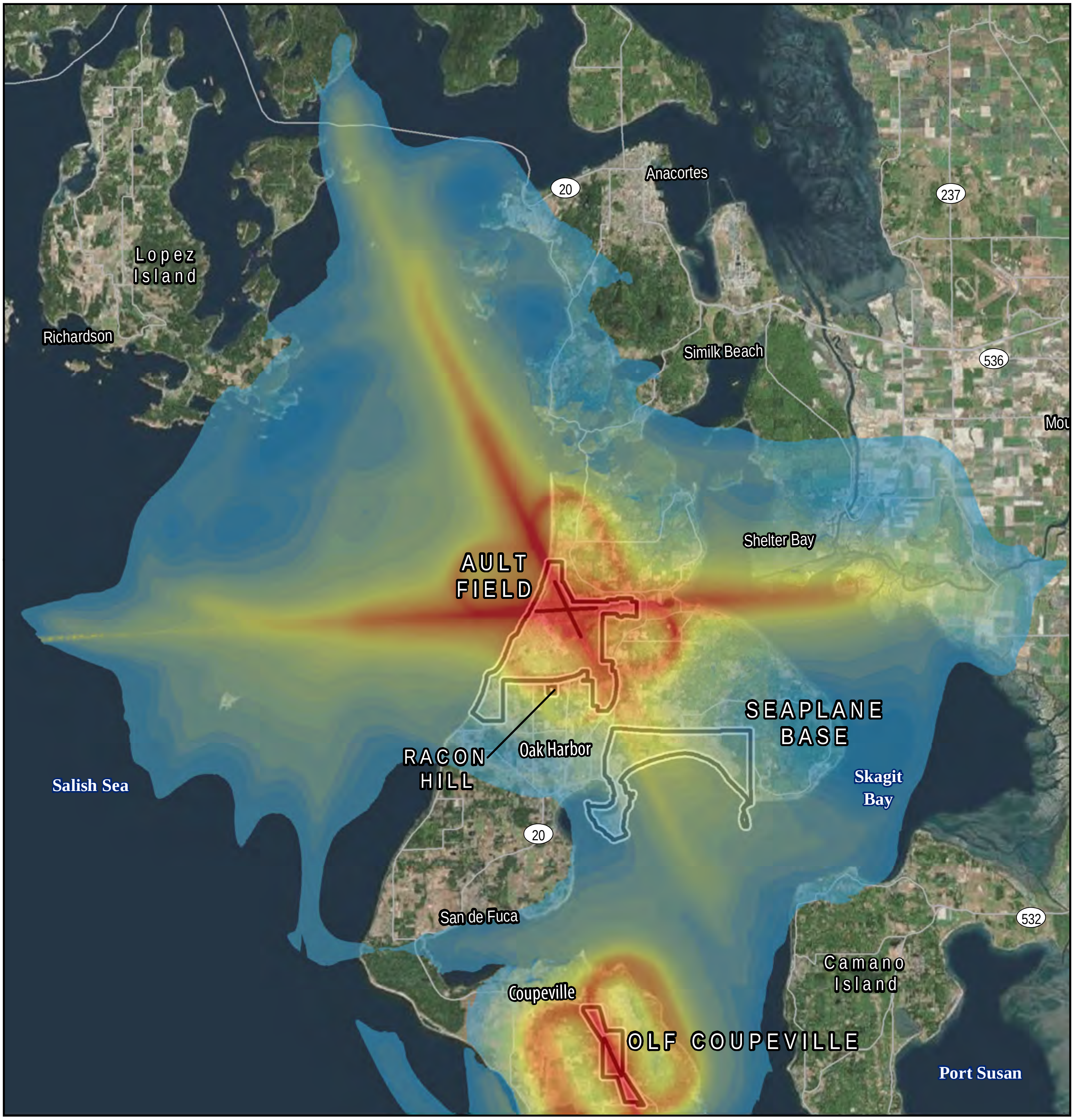

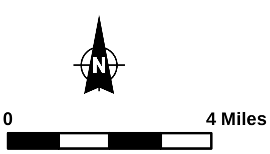

Legend

Highway

Runway

Installation Area

Noise gradient (dB DNL)

55 dB

60 dB

65 dB

70 dB

75 dB

80 dB

85 dB

90 dB

Figure 4-3
2021 AICUZ Noise Gradient, Ault Field
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

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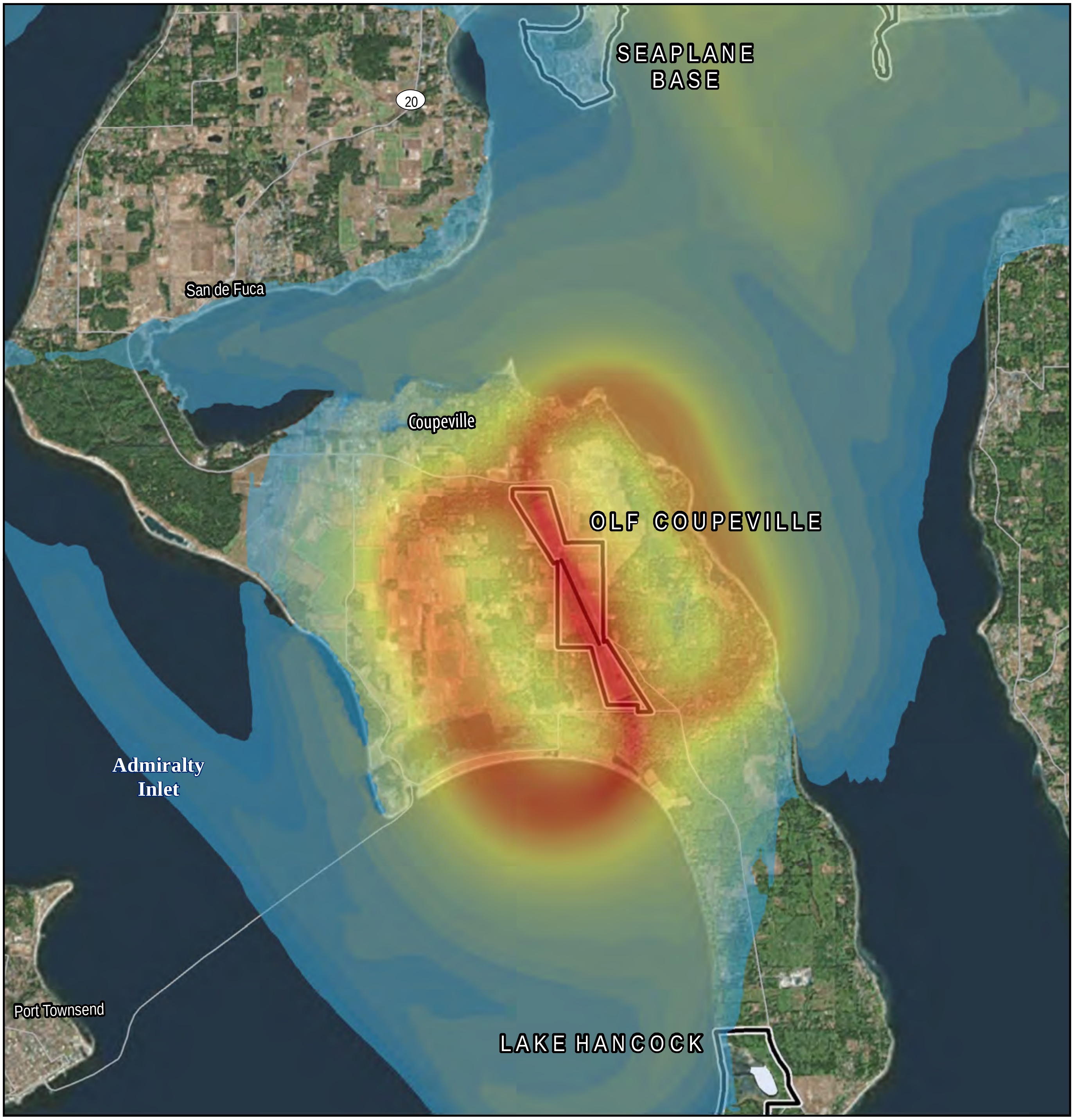

0 1 Miles

Legend

- Highway
- Runway
- Installation Area

Noise gradient (dB DNL)

- 55 dB
- 60 dB
- 65 dB
- 70 dB
- 75 dB
- 80 dB
- 85 dB
- 90 dB

Figure 4-4
2021 AICUZ Noise Gradient, OLF Coupeville
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

4.4.3 Comparison of Noise Contours

A comparison of the 2005 and 2021 noise contours shows some similarities in shape; however the 2021 AICUZ contours have increased in overall size and coverage for both Ault Field and OLF Coupeville. The changes are attributed to several factors, including:

- Changes in aircraft types (2005 contours included aircraft no longer flown at NASWI);
- Changes in aircraft flight patterns;
- Changes in operational levels (the number of operations has increased from 2005 to 2021); and
- Improved noise models (discussed in Section 1.3.2, Changes that Necessitate this AICUZ Update).

Ault Field

As shown in Table 4-1, the 2021 noise contours (Noise Zones 2 and 3) cover 53,289 acres, with approximately 65 percent of that acreage occurring off-station over water. Compared with the 2005 contours, the 2021 contours have increased the land and water area within the noise contours. A majority of the increase from 2005 to 2021 occurs over a waterbody. Figure 4-5 illustrates the changes in noise contours at Ault Field from 2005 to 2021.

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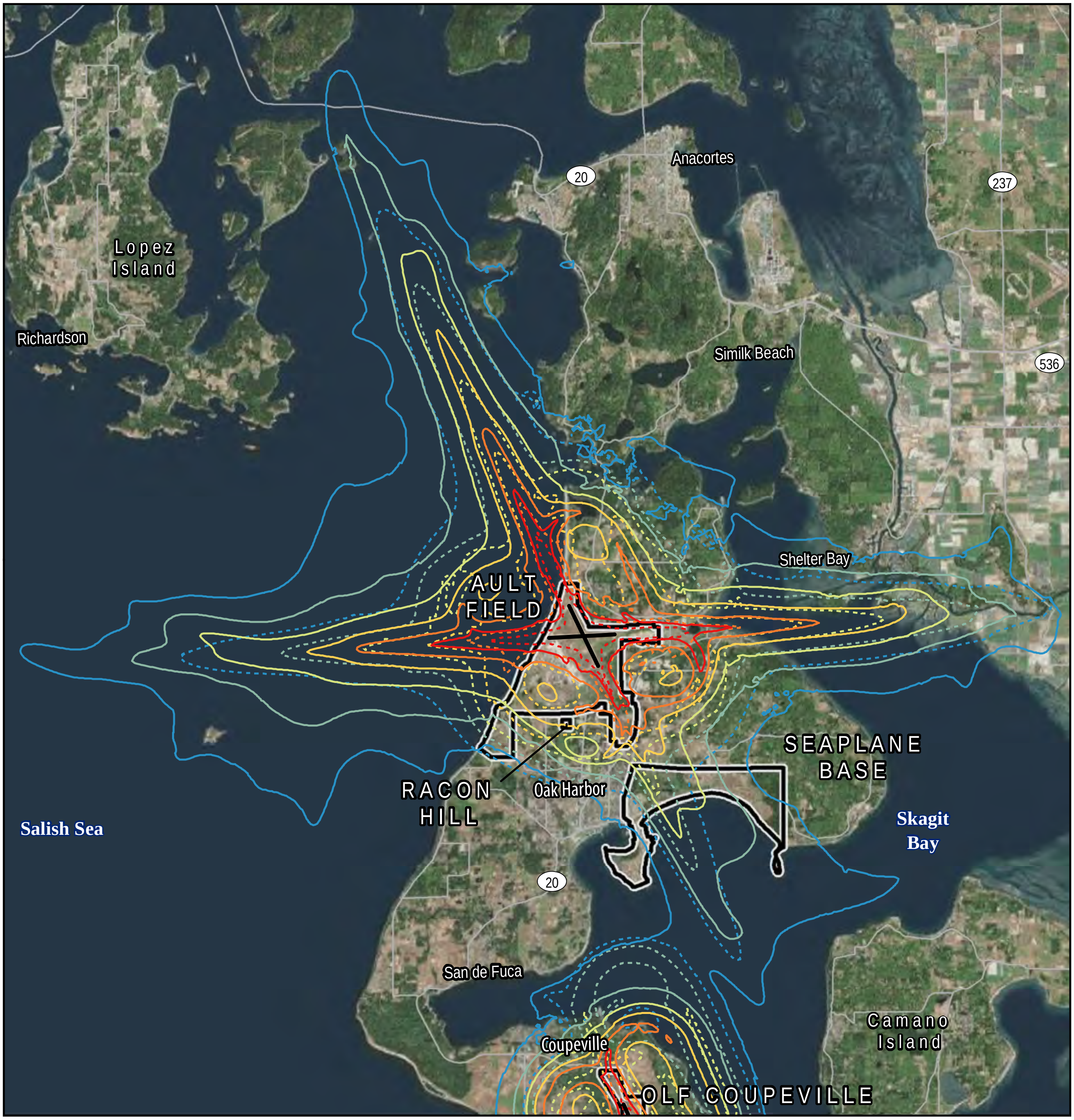

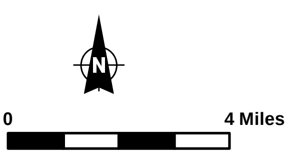

Legend

Highway
Runway
Installation Area

Noise Contour (2021)	Noise Contour (2005)
60 dB DNL	60 dB DNL
65 dB DNL	65 dB DNL
70 dB DNL	70 dB DNL
75 dB DNL	75 dB DNL
80 dB DNL	80 dB DNL
85 dB DNL	85 dB DNL

Figure 4-5
Comparison of 2005 and 2021 AICUZ Noise Contours, Ault Field
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

TABLE 4-1 LAND AND WATER AREAS WITHIN THE AULT FIELD 2021 NOISE ZONES (ACRES)

NOISE ZONE	LAND ON AULT FIELD	LAND OFF-STATION	NAVY OWNED LAND OFF-STATION	WATERBODY OFF-STATION	GRAND TOTAL
Noise Zone 2 (65 to 74 dB DNL)	208	6,918	1,053	25,404	**33,583**
Noise Zone 3 (75 to 85+ dB DNL)	3,628	6,425	17	9,636	**19,706**
Total	**3,836**	**13,343**	**1,070**	**35,041**	**53,289**

Source:
2018 Final EIS for EA-18G Growler Airfield Operations at NASWI Complex (Navy 2018[a])

Notes:
Values were rounded to the nearest whole number.
Noise Zone 1 (DNL less than 65) does not have recommended land use controls per the Navy's recommendations; therefore, acreages have not been calculated and the area was not included in the land use compatibility analysis in Chapter 7, Land Use Compatibility Analysis and Recommendations.

OLF COUPEVILLE

As shown in Table 4-2, the 2021 noise contours (Noise Zones 2 and 3) cover 16,499 acres, with approximately 61 percent of that acreage occurring off-station over land. Compared with the 2005 contours, the 2021 Noise Zones 2 and 3 both increased in size. Figure 4-6 illustrates the changes in noise contours at OLF Coupeville from 2005 to 2021.

TABLE 4-2 LAND AND WATER AREAS WITHIN THE OLF COUPEVILLE 2021 NOISE ZONES (ACRES)

NOISE ZONE	LAND ON OLF COUPEVILLE	LAND OFF-STATION	NAVY OWNED LAND OFF-STATION	WATERBODY OFF-STATION	GRAND TOTAL
Noise Zone 2 (65 to 74 dB DNL)	-	2,720	-	3,617	**6,337**
Noise Zone 3 (75 to 85+ dB DNL)	670	7,494	-	1,998	**10,162**
Total	**670**	**10,214**	**-**	**5,615**	**16,499**

Source:
2018 Final EIS for EA-18G Growler Airfield Operations at NASWI Complex (Navy 2018[a])

Notes:
Values were rounded to the nearest whole number.
Noise Zone 1 (DNL less than 65) does not have recommended land use controls per the Navy's recommendations; therefore, acreages have not been calculated and the area was not included in the land use compatibility analysis in Chapter 7, Land Use Compatibility Analysis and Recommendations.

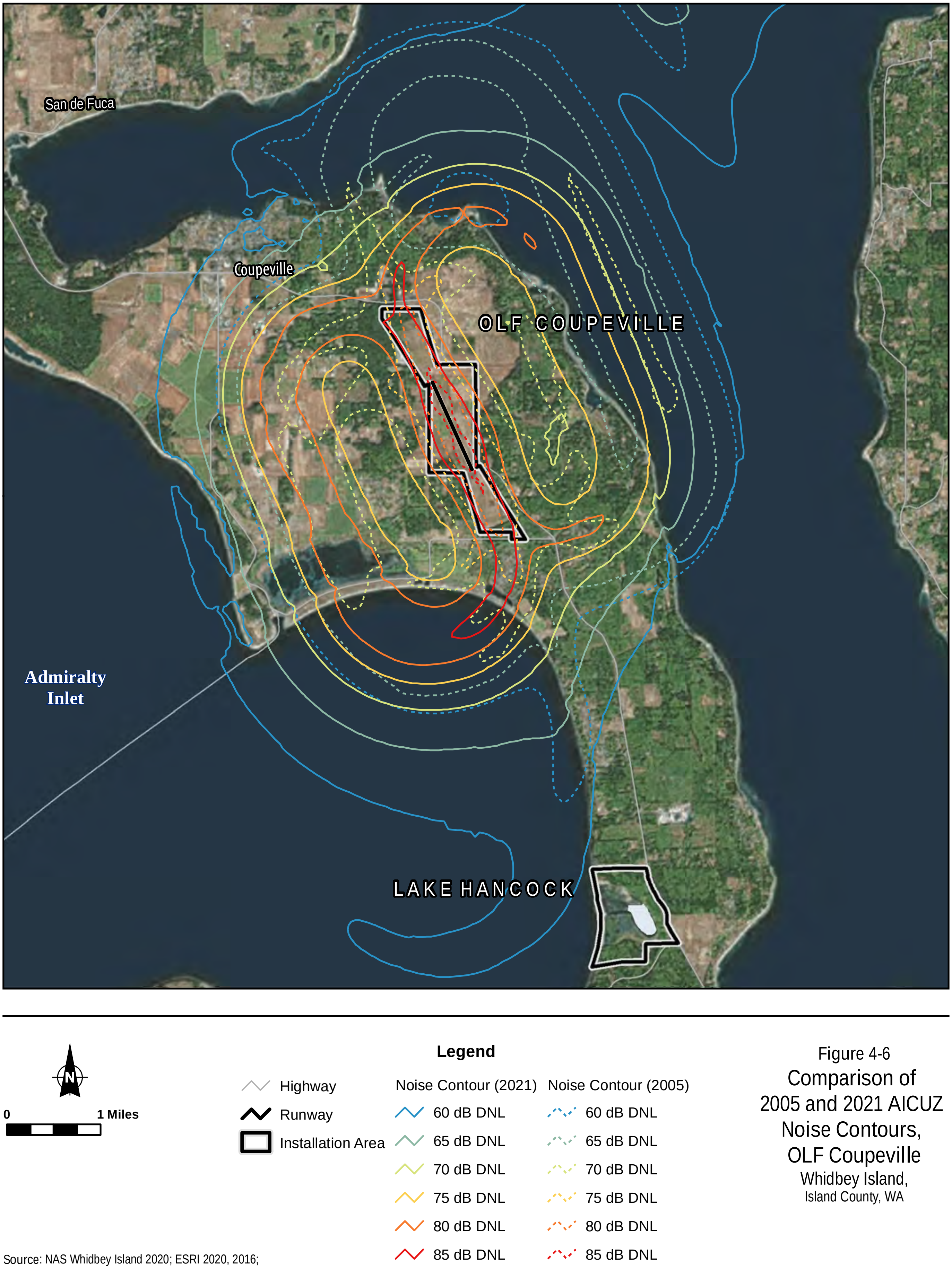

Figure 4-6
Comparison of 2005 and 2021 AICUZ Noise Contours, OLF Coupeville
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

5 AIRFIELD SAFETY

5.1 Accident Potential Zones

5.2 AICUZ Clear Zones and APZs

5.3 Imaginary Surfaces

5.4 Flight Safety

Community and airfield safety is paramount to the Navy. The Navy has established a flight safety program and areas of accident potential around Ault Field and OLF Coupeville to assist in planning for health, safety, and welfare in communities near the airfields. Cooperation between the Navy and local communities can improve land use planning and development surrounding naval airfields.

Identifying safety issues assists the community in developing land uses compatible with airfield operations. These issues include areas of accident potential and hazards around the airfield that obstruct or interfere with aircraft arrivals and departures, pilot vision, communications, or aircraft electronics. While aircraft mishaps are rare, they do occur. Aircraft safety and mishaps at NASWI are discussed in detail in this section.

5.1 ACCIDENT POTENTIAL ZONES

Recognizing the need to identify areas of accident potential, in the 1960s, 1970s, and 1980s, the military conducted studies of historic accidents and operations data throughout the military. The studies showed that most aircraft mishaps occur on or near the runway, diminishing in likelihood with distance from the runway. Based on the studies, the DOD identified APZs as areas where an aircraft accident would most likely occur. APZs are not a prediction of the number of accidents or the odds of an accident occurring; APZs reflect the historical distribution of accidents near airfields.

APZs align with departure, arrival, and pattern flight tracks, and are designed to minimize potential harm if a mishap were to occur by limiting activities in the designated APZs. The Navy and local planning authorities use APZs to ensure compatible development in close proximity to runway ends and slightly beyond. Although the likelihood of an accident is remote, the Navy recommends that land uses that concentrate large numbers of people, such as apartments, churches, and schools, be avoided within APZs.

5.1.1 Clear Zone and APZ Requirements and Dimensions

APZ configurations and dimensions derive from the AICUZ Instruction and are established for all runway classifications. There are three APZs: Clear Zone, APZ I, and APZ II. APZs are, in part, based on the number of operations conducted at the airfield—more specifically, the number of operations conducted for specific flight tracks. The runways at Ault Field and OLF Coupeville are Class B runways. The AICUZ Instruction defines the components of standard APZs for Class B, as follows, and as shown on Figure 5-1:

> Navy regulations require APZ I to be designated under any flight tracks that have 5,000 or more annual operations (departures or approaches). An APZ II area is designated whenever APZ I is required.
>
> In the unlikely event of an accident near the airfield, historical data suggests that the probability of an accident increases as the distance to the runway decreases. APZs reflect this relationship graphically.

- Clear Zone. The Clear Zone is a trapezoidal area immediately beyond the end of the runway and outward along the extended runway centerline for a distance of 3,000 feet. The Clear Zone measures 1,500 feet in width at the runway threshold and 2,284 feet in width at the outer edge. A Clear Zone is required for all active runways and should remain undeveloped.
- APZ I. APZ I is the rectangular area beyond the Clear Zone that still has a measurable potential for aircraft accidents relative to the Clear Zone. APZ I is provided under flight tracks that experience 5,000 or more annual operations (departures or approaches). APZ I is 3,000 feet in width and 5,000 feet in length, and may be rectangular or curved to conform to the shape of the predominant flight track.
- APZ II. APZ II is the rectangular area beyond APZ I and has less measurable potential for aircraft accidents relative to APZ I or the Clear Zone. APZ II is always provided where APZ I is required. The dimensions of APZ II are 3,000 feet in width by 7,000 feet in length and, as with APZ I, may curve to correspond with the predominant flight track.

APZs extend from the end of the runway but apply to the predominant arrival and/or departure flight tracks used by the aircraft. Therefore, if an airfield has more than one predominant flight track to or from the runway, APZs can extend in the direction of each flight track, as shown on Figure 5-1. As the distance of a flight track to an installation decreases, the potential for flight tracks to overlap or converge increases. When similar mode tracks align (e.g., straight-in arrival, overhead break arrival, arrival portion of a pattern operation), the operation counts are combined to determine if the number of annual operations requires the designation as APZ I. The AICUZ Instruction permits modification of APZ dimensions for safety purposes and specific operations. Per the Instruction, if the APZ annual operations threshold is fulfilled due to FCLP operations, then APZ II shall extend the entire length of the FCLP track, resulting in a closed loop for the entire pattern.

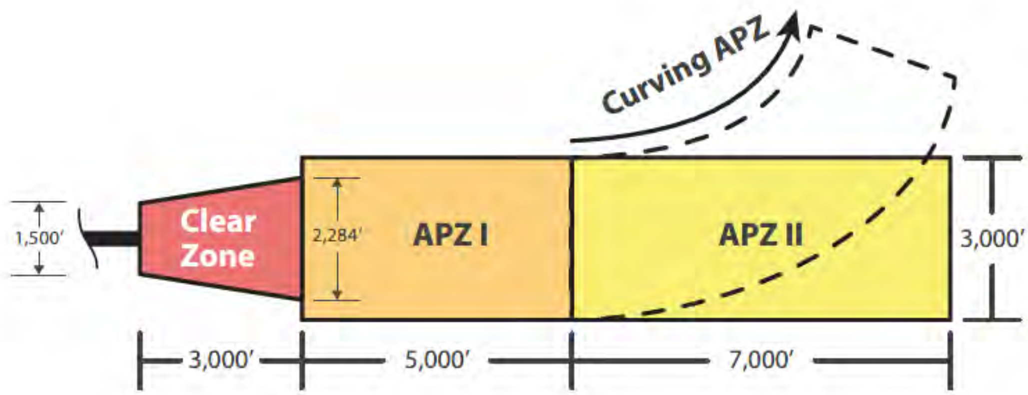

FIGURE 5-1 STANDARD CLASS B RUNWAY, FIXED-WING APZS

Within the Clear Zone most uses are incompatible with military aircraft operations. For this reason, the Navy's general policy is to acquire real property interests within the Clear Zone to ensure incompatible development does not occur. Within APZ I and APZ II, DOD policy recommends that high-density uses should be restricted. Chapter 7, Land Use Compatibility Analysis and Recommendations, further explains land use compatibility within Clear Zones and APZs.

5.2 AICUZ Clear Zones and APZs

The following sections present the 2021 APZs for NASWI Ault Field and OLF Coupeville, including a detailed discussion of their development and the land areas within the APZs. Also provided are comparisons and figure overlays with 2005 AICUZ APZs that can be used to identify changes to APZs based on projected aircraft operations. An analysis of land use and compatibility within APZs for Ault Field and OLF Coupeville is provided and discussed in Section 7.2, Land Use Compatibility Analysis.

5.2.1 2021 Clear Zones and APZs

The NASWI 2021 AICUZ APZs were developed based on the projected annual aircraft operations presented in the 2018 Growler EIS. The 2021 AICUZ Clear Zones and APZs for Ault Field and OLF Coupeville are presented on Figures 5-2 and 5-3, respectively. The 2021 APZs shown on the figures represent the detailed aircraft operations counts, flight tracks, and runway utilization data presented in Chapter 3, Aircraft Operations, and the AICUZ Instruction APZ development guidance. The analysis of the data and application of the instruction results in APZ combinations for both NASWI Ault Field and OLF Coupeville. A brief discussion of the individual APZs are provided in this section and the acreages associated with the 2021 APZs are provided in Table 5-1 (presented at the end of this section).

Ault Field

Runway 07 (Approach End) / Runway 25 (Departure End)

Clear Zones are required both for the approach end of Runway 07 and the departure end of Runway 25 (Figure 5-2). The combined operations for the flight tracks for standard arrivals, the arrival portion of the GCA patterns, and the arrival portion of the closed pattern, which are similar, exceed 5,000 annual operations and require APZs I and II. APZs I and II for the approach end of Runway 07 extend straight off the runway over water to the west of Ault Field. Similarly, based on the number of annual operations, the combined straight-out departure flight tracks for Runway 25 require APZs I and II. In addition, the number of annual operations for the combined closed pattern flight tracks total over 5,000 annual operations and require curved APZs I and II at the departure end of Runway 25. The APZs for the approach end of Runway 07 and departure end of Runway 25 extend over water west of the airfield and over land in Oak Harbor south of the installation.

Runway 25 (Approach End) / Runway 07 (Departure End)

Clear Zones are required for both the approach end of Runway 25 and the departure end of Runway 07. The combined flight tracks for standard arrivals, the arrival portion of the GCA pattern, and the arrival portion of the closed pattern flight tracks total over 15,000 annual operations and require standard straight APZs I and II. In addition, the combined closed pattern operations total over 5,000 operations and meet the criteria for curved APZs I and II. An offset departure track for Runway 07 also contributes to the fan shape of the APZs at this end of the runway. The APZs for the approach end of Runway 25 and departure end of Runway 07 extend over land in Island County east of the installation.

Runway 32 (Approach End) / Runway 14 (Departure End)

Clear Zones are required for both the approach end of Runway 32 and the departure end of Runway 14. The straight-out departures total over 6,000 annual operations and meet the criteria for APZs I and II for the departure end of Runway 14. In addition, the straight-out departures, when combined with the departure portion of the GCA pattern and the departure portion of the closed-pattern flight tracks, total over 9,000 annual operations. APZs I and II for the departure end of Runway 14 extend straight out from the runway over land to the southeast of the installation in Island County.

Runway 14 (Approach End) / Runway 32 (Departure End)

Clear Zones are required for both the approach end of Runway 14 and the departure end of Runway 32. For the approach end of Runway 14, the combined flight tracks for standard arrivals, the arrival portion of the GCA pattern, and the arrival portion of the closed patterns, total over 9,000 operations and meet the criteria for APZs I and II. The APZs extend over water and land to the north of the installation in Island County.

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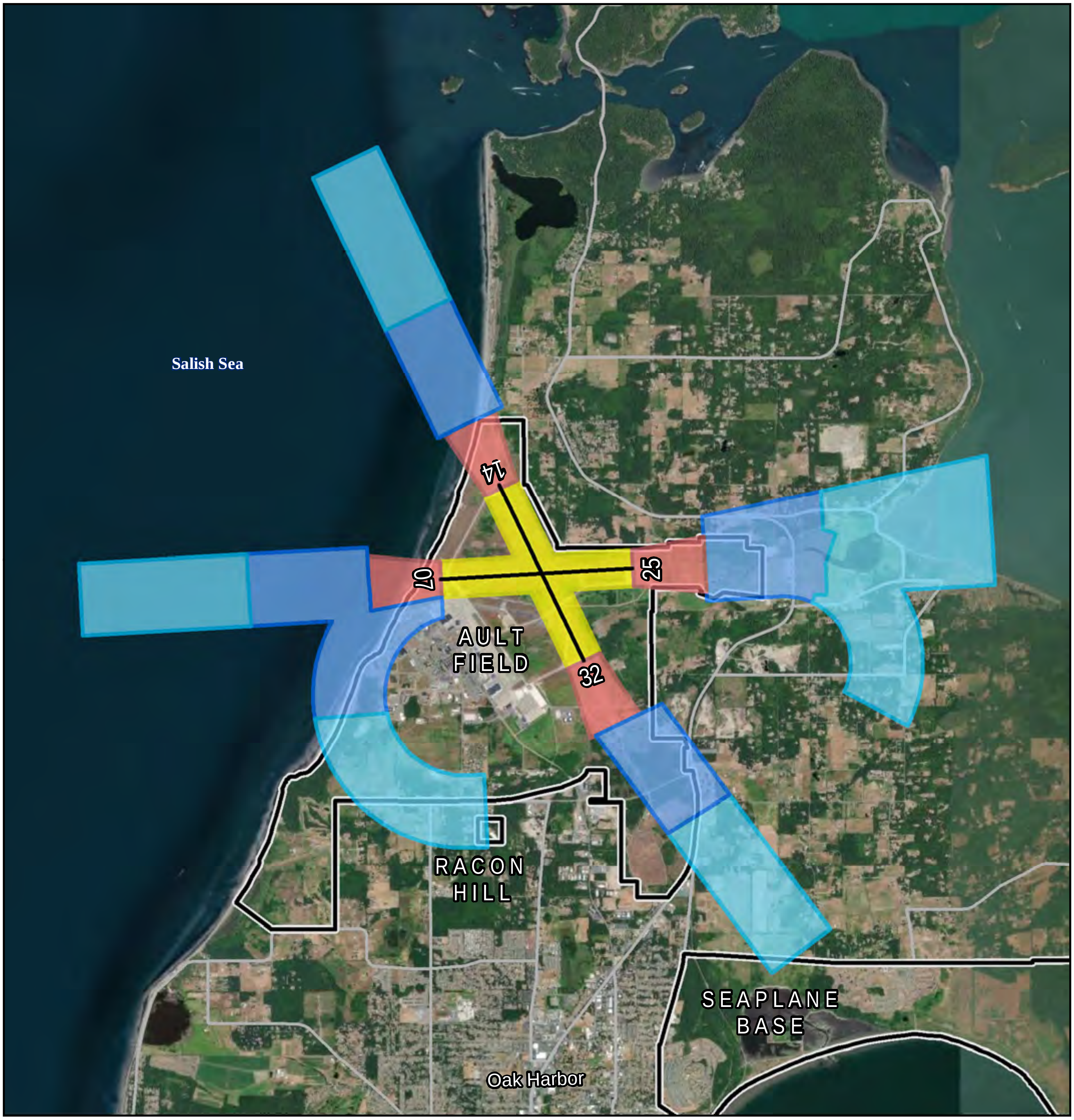


N

0 4,000 Feet

Legend

Highway

Installation Area

2021 Accident Potential Zones (APZs)

- Primary Surface
- Clear Zone
- APZ I
- APZ II

Figure 5-2
2021 AICUZ Clear Zones and Accident Potential Zones, Ault Field
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020c; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

OLF Coupeville

Runway 32

Clear zones are required for Runway 32. Combined FCLP flight tracks on Runway 32 at OLF Coupeville meet the criteria for APZs I and II. APZ II was applied to the entire FCLP track beyond APZ I, resulting in a closed loop for the entire pattern per the AICUZ Instruction (Figure 5-3). The APZs extend over land west of OLF Coupeville in Island County and water south of the OLF. The APZs presented match the notional configuration presented in the 2018 Final EIS for EA-18G Growler Airfield Operations.

Runway 14

Clear zones are required for Runway 14. None of the single flight tracks or combined similar mode flight tracks for Runway 14 at OLF Coupeville meet the criteria for APZs; therefore, APZs I and II were not developed for this runway.

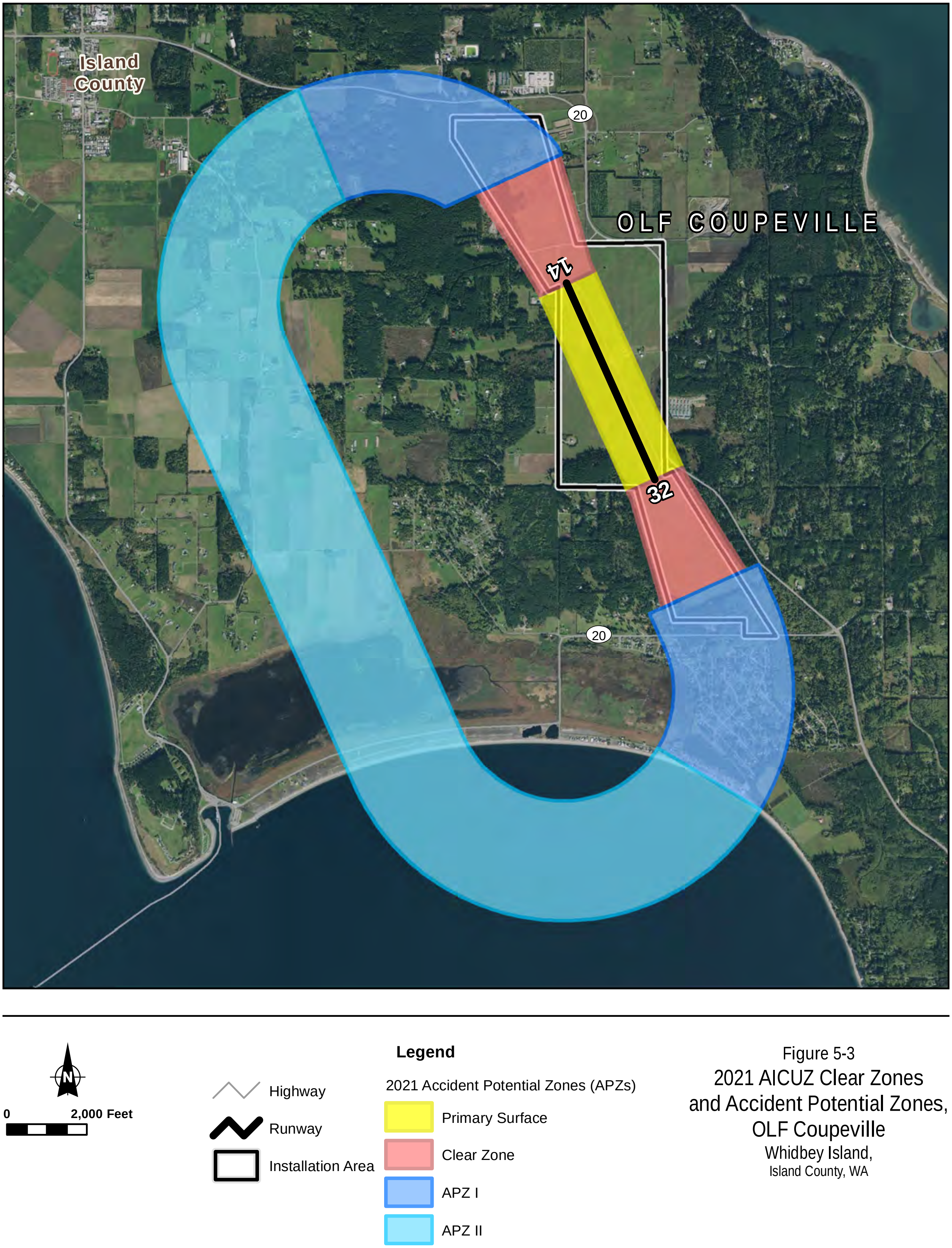


Figure 5-3
2021 AICUZ Clear Zones and Accident Potential Zones, OLF Coupeville
Whidbey Island, Island County, WA

Source: Ecology and Environment, Inc. 2020; NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012.

5.2.2 Comparison of 2005 and 2021 Clear Zones and APZs

Ault Field

As shown in Table 5-1, 5,448 acres are within the 2021 Clear Zones and APZs for Ault Field. Over 50 percent of the off-station APZ area is over the waters surrounding Whidbey Island, resulting in less than 2,000 land acres within the APZs outside of the installation boundary. Overall, the total area within the APZs has decreased from 2005. The reduction is due to loss of APZ II coverage to the northwest (over the water) and southeast in the area east of Highway 20. A comparison of the 2005 and 2021 Clear Zones and APZs for Ault Field are presented on Figure 5-4. It is important to note that, after the 2005 AICUZ, the City of Oak Harbor implemented larger APZs than what were recommended in the AICUZ. For this comparison we are utilizing the Navy APZs presented in the AICUZ rather than the larger ones implemented by the municipality.

TABLE 5-1 LAND AND WATER AREAS WITHIN THE AULT FIELD 2021 CLEAR ZONE AND APZS (ACRES)

	LAND ON AULT FIELD	LAND OFF-STATION	NAVY OWNED LAND OFF-STATION	WATERBODY OFF-STATION	GRAND TOTAL
Clear Zone	376	17	-	120	**513**
APZ I	519	440	-	867	**1,826**
APZ II	349	1,441	9	1,310	**3,109**
Total	**1,245**	**1,898**	**9**	**2,297**	**5,448**

Source:
Based on the operation numbers from the 2018 Final EIS for EA-18G Growler Airfield Operations at NASWI Complex (Navy 2018[a]) and the Final Approved 2021 APZ Development Report.

Notes:
Values were rounded to the nearest whole number.

Factors that contribute to the change in APZs at Ault Field between the 2005 AICUZ and the 2021 AICUZ are noted below:

- At the departure end of Runway 25, the APZs have been shifted closer to the runway to better reflect current flight paths.
- At the approach end of Runway 25 and the departure end of Runway 07, the APZs have been shifted closer to the runway to better reflect current flight paths.
- The APZs off the departure end of Runway 07 and the approach end of Runway 25 are the result of the overlap of operational flight tracks off each runway end, resulting in a wider than usual standard APZ configuration.
- The 2005 AICUZ shows a curved APZ II on both the departure and approach end of Runway 14; however, combined flight tracks for closed pattern operations from this runway have decreased to below 5,000 annual operations. Decreases in EA-18G operations using these closed-pattern flight tracks compared to EA-6B operations led to the removal of the curved APZ II in this AICUZ Study.

OLF COUPEVILLE

In 2005, OLF Coupeville flight operations did not meet the 5,000 threshold to warrant APZ I and II. However, as an active airfield, it did require Clear Zones at each runway end. The addition of a closed-loop APZ at OLF Coupeville represents a substantial change from the 2005 AICUZ Study; however, from the 1977 AICUZ to 2005, operational levels for both ends of the OLF Coupeville runway supported closed-loop APZs. As shown in Table 5-2, 2,784 acres are within the 2021 Clear Zones and APZs for OLF Coupeville. A comparison of the 2005 and the 2021 Clear Zones and APZs for OLF Coupeville are presented on Figure 5-5.

TABLE 5-2 LAND AND WATER AREAS WITHIN THE OLF COUPEVILLE 2021 CLEAR ZONE AND APZS (ACRES)

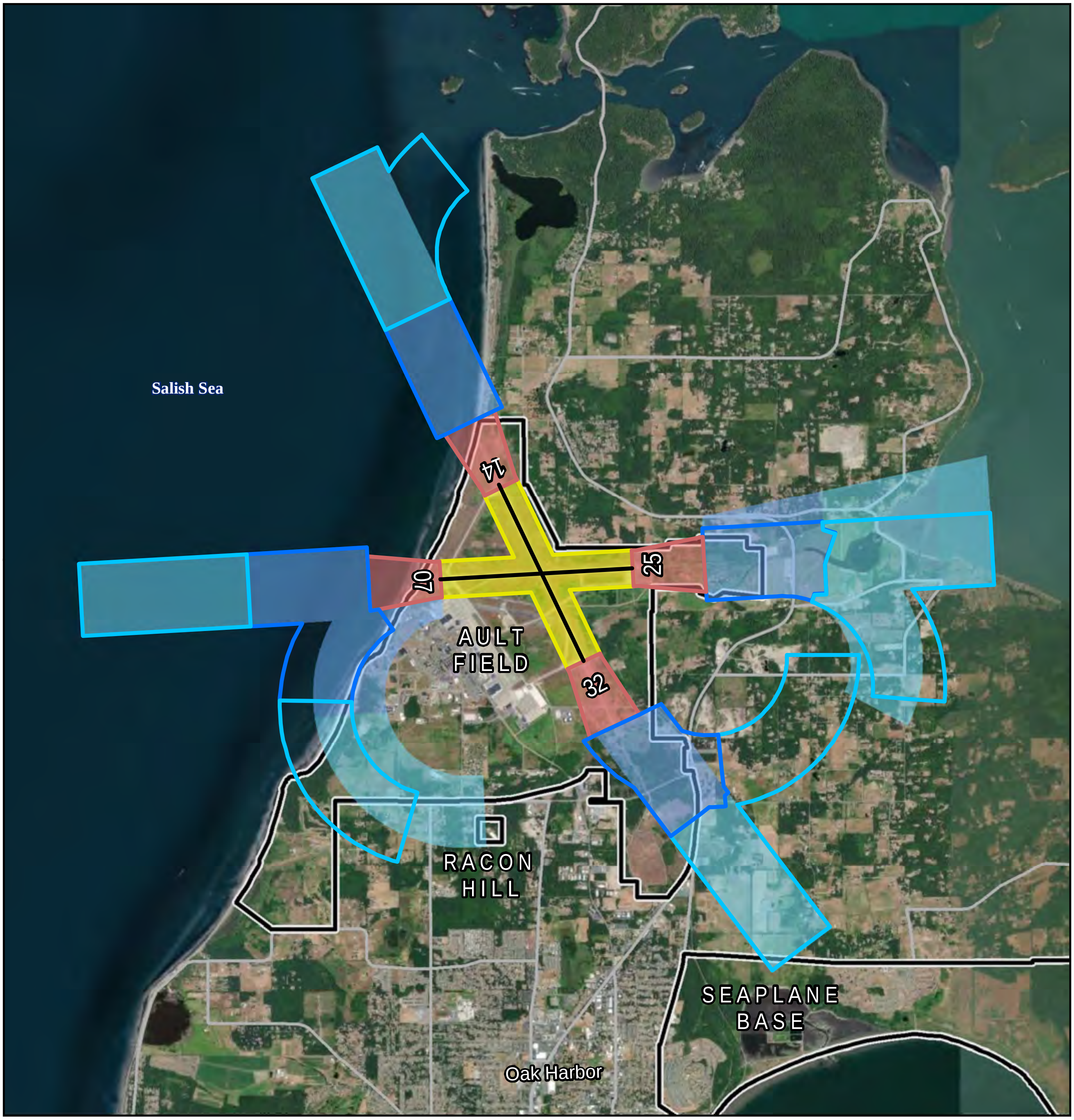
	LAND ON OLF COUPEVILLE	LAND OFF-STATION	NAVY OWNED LAND OFF-STATION	WATERBODY OFF-STATION	GRAND TOTAL
Clear Zone	200	56	-	-	**257**
APZ I	116	572	-	-	**687**
APZ II	-	1,216	-	623	**1,839**
Total	**316**	**1,845**	**-**	**623**	**2,784**

Source:
Based on the operation numbers from the 2018 Final EIS for EA-18G Growler Airfield Operations at NASWI Complex (Navy 2018[a]) and the Final Approved 2021 APZ Development Report.

Notes:
Values were rounded to the nearest whole number.

The main factor that contributed to the change in APZs at OLF Coupeville between the 2005 AICUZ and the 2021 AICUZ is noted below:

- Overall, the change in APZs is attributed to the increase in aircraft operations. Runway 32 combined FCLP tracks total 7,475 annual operations, satisfying the operational criteria for application of APZ I; thus the 2021 APZ II was applied to the entire FCLP track beyond APZ I, resulting in a closed-loop for the entire pattern.



Legend

Highway

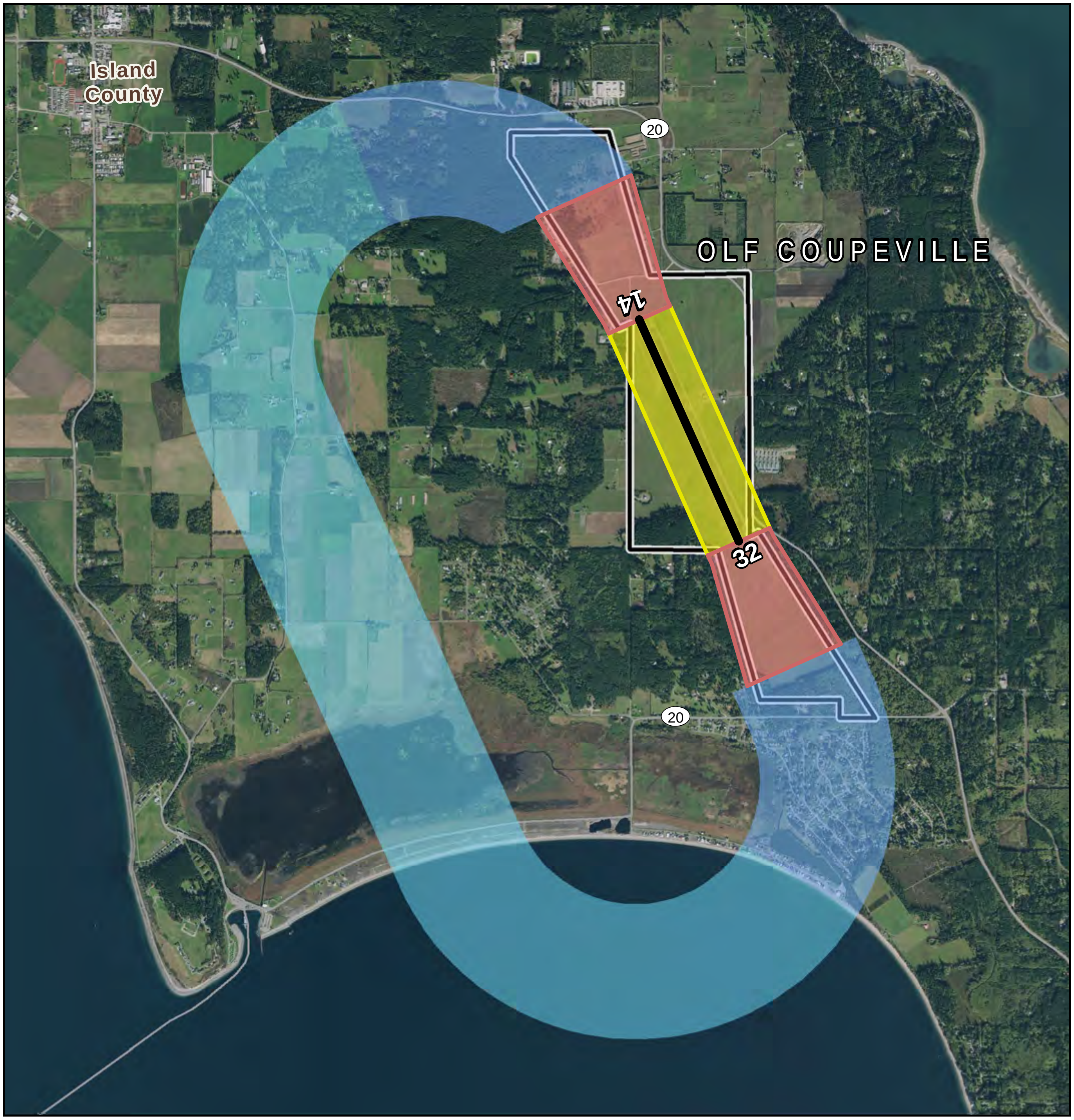
Installation Area

2021 Accident Potential Zones (APZs)
- Primary Surface
- Clear Zone
- APZ I
- APZ II

2005 Accident Potential Zones (APZs)
- Primary Surface
- Clear Zone
- APZ I
- APZ II

Figure 5-4
Comparison of 2005 and 2021 AICUZ Clear Zones and APZs, Ault Field
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020c; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.



0 2,000 Feet

Legend

Highway
Runway
Installation Area

2021 Accident Potential Zones (APZs)
- Primary Surface
- Clear Zone
- APZ I
- APZ II

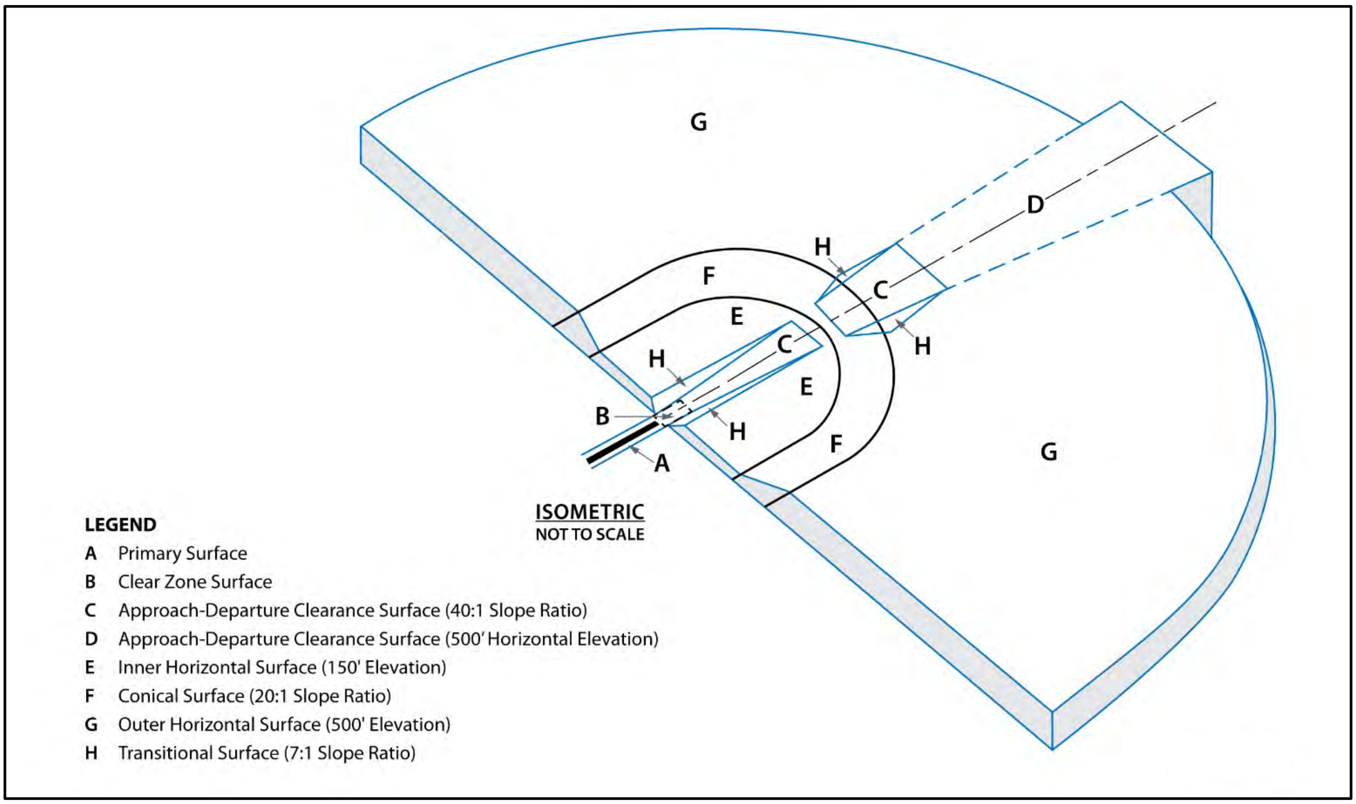
2005 Accident Potential Zones (APZs)
- Primary Surface
- Clear Zone

Figure 5-5
Comparison of 2005 and 2021 AICUZ Clear Zones and APZs OLF Coupeville
Whidbey Island,
Island County, WA

Source: Ecology and Environment, Inc. 2020. NAS Whidbey Island 2020c; ESRI 2020, 2016; Island County 2012.

5.3 Imaginary Surfaces

The Navy and the FAA identify a complex series of imaginary planes and transition surfaces that define the airspace that needs to remain free of obstructions around an airfield. Obstruction-free imaginary surfaces help to ensure safe flight approaches, departures, and pattern operations. Obstructions include natural terrain and man-made features, such as buildings, towers, poles, wind turbines, cell towers, and other vertical obstructions to airspace navigation. Fixed-wing runways and rotary-wing runways/helipads have different imaginary surfaces. Brief descriptions of the imaginary surfaces for fixed-wing Class B runways (runways at NASWI are all Class B runways) are provided on Figure 5-6 and in Table 5-3. In general, no aboveground structures are permitted in the primary surface of Clear Zones, and height restrictions apply to transitional surfaces and approach and departure surfaces. Height restrictions are more stringent as one approaches the runway and flight path.



Source: DOD 2020

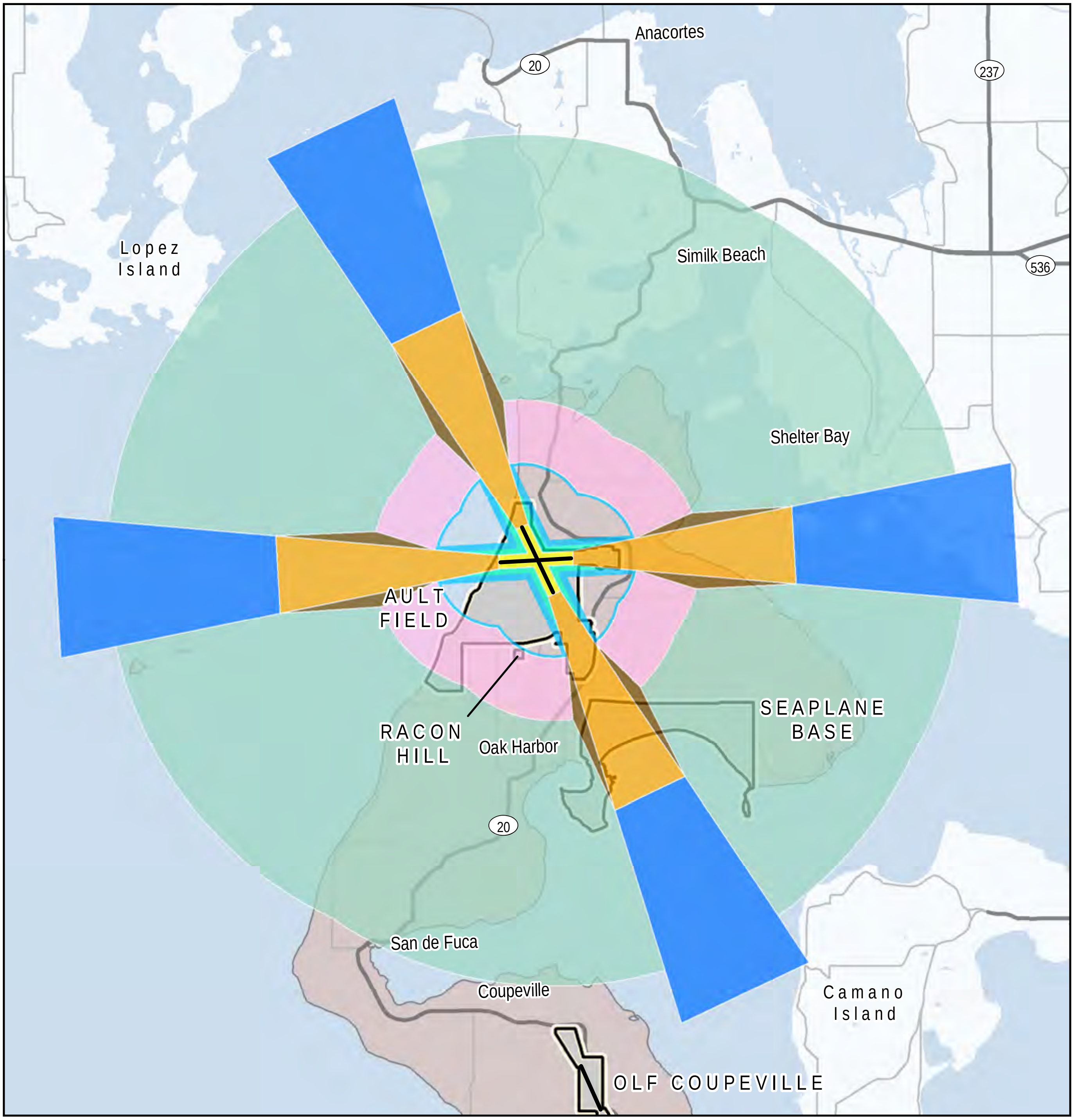
FIGURE 5-6 IMAGINARY SURFACES AND TRANSITION PLANES FOR CLASS B FIXED-WING RUNWAYS

TABLE 5-3 IMAGINARY SURFACES – CLASS B FIXED-WING RUNWAYS

PLANES AND SURFACES	ASSOCIATED AREA ON FIGURE 5-6	GEOGRAPHICAL DIMENSIONS
Primary Surface	A	Aligned (longitudinally) with each runway and extending 200 feet from each runway end. The width is 1,500 feet.
Clear Zone	B	Located immediately adjacent to the end of the runway and extending 3,000 feet beyond the end of the runway. 1,500 feet wide and flares out to 2,284 feet wide.
Approach-Departure Clearance Surfaces	C, D	An inclined or combination inclined and horizontal plane, symmetrical about the runway centerline. The slope of the surface is 50:1 until an elevation of 500 feet and continues horizontally 50,000 feet from the beginning. The outer width is 16,000 feet.
Inner Horizontal Surface	E	An oval-shaped plane 150 feet above the established airfield elevation. Constructed by scribing an arc with a radius of 7,500 feet around the centerline of the runway.
Outer Horizontal Surface	G	A horizontal plane located 500 feet above the established airfield elevation, extending outward from the conical surface for 30,000 feet.
Conical Surface	F	An inclined plane that extends from the inner horizontal surface outward and upward at a 20:1 slope and extends for 7,000 feet and to a height of 500 feet above the established airfield elevation.
Transitional Surface	H	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 a slope of 7:1 from the sides of the primary surface and from the sides of the approach surfaces.

Source:
DOD 2020

Imaginary surfaces for NASWI are depicted on Figures 5-7 and 5-8. As noted above, each runway has assigned imaginary surfaces; therefore, since Ault Field has two runways and OLF Coupeville has one runway, imaginary surfaces are applied to each runway, resulting in overlapping surfaces. Northwest and west portions of the imaginary surfaces extend out over the coastline and the Salish Sea. The east and southern portions extend within the unincorporated areas of Island County and the city of Oak Harbor.



Legend

- U.S. and State Highway
- Major Road
- Installation Area
- Whidbey Island
- Waterbody

Imaginary Surfaces

- App/Dept 50:1 Slope Ratio
- App/Dept 500' Elevation
- App/Dept Transitional Surface
- Conical Surface
- Inner Horizontal Surface
- Outer Horizontal Surface
- Primary Surface
- MainTransitional Surface

Figure 5-7
Imaginary Surfaces, Class B, Fixed-Wing Runway, Ault Field
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2013; ESRI 2020, 2012, 2016; Island County 2012.

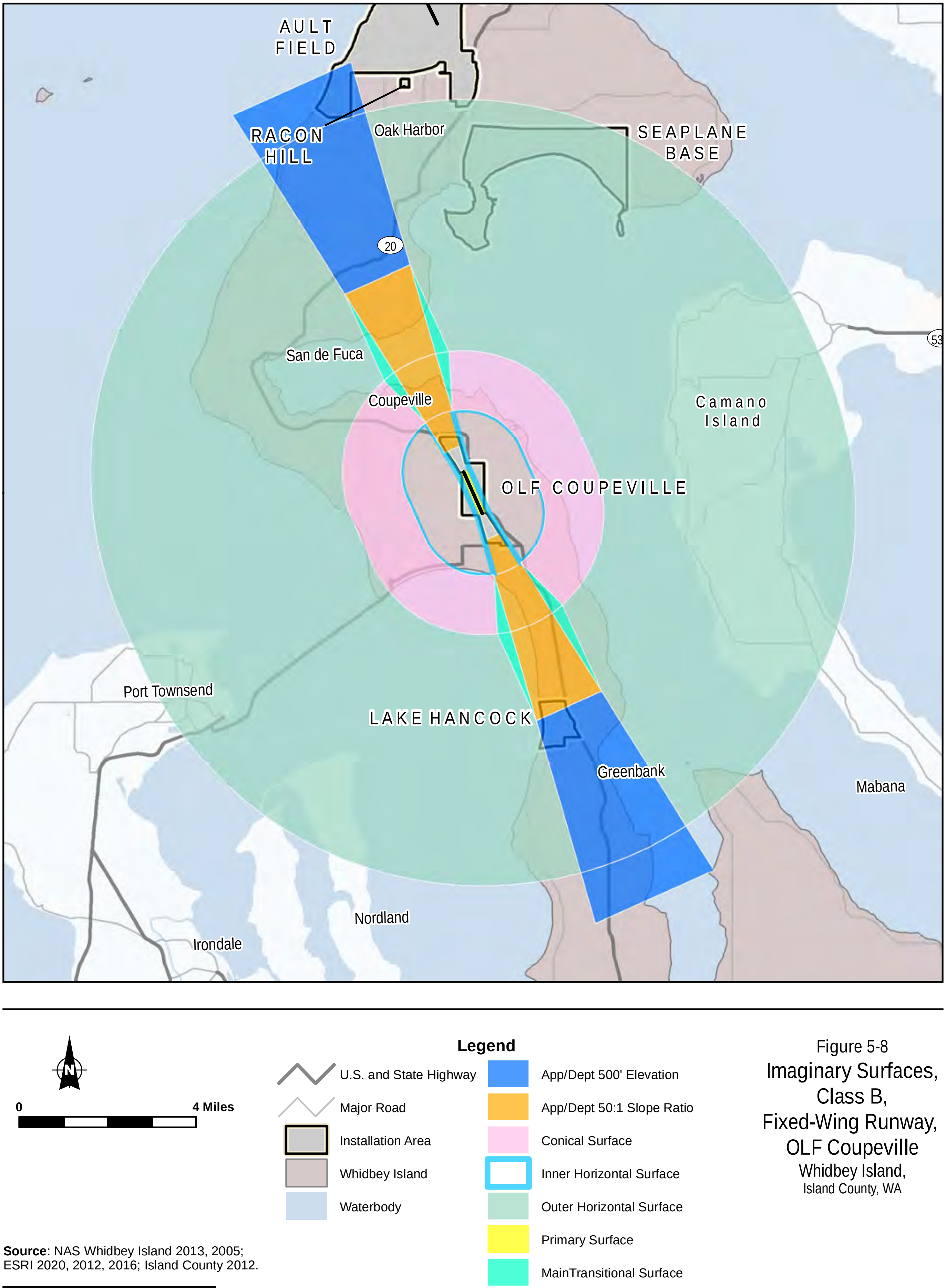


Figure 5-8
Imaginary Surfaces, Class B, Fixed-Wing Runway, OLF Coupeville
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2013, 2005; ESRI 2020, 2012, 2016; Island County 2012.

5.4 Flight Safety

Flight safety programs are designed to reduce hazards that cause aircraft mishaps; APZs are designed to minimize harm if a mishap occurs. Flight safety not only includes measures for pilot safety during aircraft operations, but also for the safety of those in the community. The FAA and the military define flight safety zones (imaginary surfaces) below aircraft arrival and departure flight tracks around airfields. Heights of structures and trees are restricted in these imaginary surfaces, and the FAA evaluates proposed construction to mitigate impacts. The flight safety zones are designed to reduce hazards that can cause an aircraft mishap. This section discusses aircraft mishaps at NASWI, hazards to flight safety that should be avoided in the airfield vicinity, and measures to avoid potential pilot interferences.

5.4.1 Aircraft Mishaps

The primary safety concern with regard to military aircraft training operations is the potential for aircraft mishaps to occur. Aircraft mishaps could be caused by mid-air collisions with other aircraft or objects, weather, mechanical failures, pilot error, or BASH (see Section 5.4.2, Bird/Animal Aircraft Strike Hazard). Although mishap rates from previous years cannot predict future mishap rates, reviewing mishap data from previous years is helpful in providing perspective. Aircraft mishaps are categorized based on the extent of property damage, loss of life, or disability they cause. The parameters of each class are evaluated and adjusted over time as replacement costs increase. Class A mishaps are the most severe and are currently classified as any mishap with total property damage of $2 million or more, or a fatality or permanent total disability. A Class A mishap does not necessarily equate to a crash and loss of aircraft. For instance, damage to an engine occurring during a flight could cost over $2 million to repair and be categorized as a Class A mishap, even though the aircraft returned safely to an airfield. Class A mishaps may also occur while the aircraft is on the ground. Mishap rates are calculated in terms of the number of mishap events per 100,000 flying hours, with combat hours excluded. Emergency and mishap response involve the procedures and equipment needed to react to mishaps on or off the installation. Elements of this response include rescue, fire suppression, security, and investigation.

From October 1, 2008, to September 30, 2017, the Growler community conducted approximately 187,642 flight hours of operations from land-based airfields. During that nine-year period, the Growler community experienced four Class A mishaps while operating from land, equivalent to a mishap rate of 2.13 per 100,000 flight hours, none of which involved a "crash." Two of these four Class A mishaps occurred at Ault Field, and both occurred with the aircraft on the ground. One mishap involved a canopy pressurization malfunction and one involved a flight line fire extinguishing agent that was pulled into an engine intake. The remaining two were flight-related mishaps that did not occur at the NAS Whidbey Island complex. No other Class A mishaps have occurred with aircraft based at NASWI. (Naval Safety Center 2017)

5.4.2 Bird/Animal Aircraft Strike Hazard

Wildlife can be a significant hazard to flight operations. Birds and wildlife are drawn to different habitat types found in the airfield environment (edges, grass, brush, wetlands, forest, water and the shoreline, and even the warm pavement of the runways). NASWI also is located within the Pacific Flyway, which includes migration routes for many migratory bird species. Due to the speed of the aircraft, collisions with wildlife can have considerable force and can cause substantial damage. Although most bird and animal strikes do not result in crashes, they can cause structural and mechanical damage to aircraft, as well as loss of flight time.

Most bird collisions occur when the aircraft is at an elevation of less than 1,000 feet. To reduce BASH, the FAA and the military recommend locating land uses that attract birds at least 10,000 feet from active movement areas of the airfields. Land uses that attract birds and other wildlife include transfer stations, landfills, golf courses, wetlands, stormwater ponds, and dredge disposal sites. Design modification can reduce the attraction of these land uses. To reduce this hazard, flight patterns and operations at NASWI are altered or limited during times of increased bird activity, usually around dawn and dusk and during migratory seasons. Additionally, NASWI employs a BASH coordinator whose objective is to mitigate and address BASH hazards.

5.4.3 Electromagnetic Interference

New generations of military aircraft are highly dependent on complex electronic systems for navigation and critical flight and mission-related functions. Consequently, care should be taken in siting activities that create EMI. The American National Standards Institute defines EMI as any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics/electrical equipment. EMI can be intentional, as in electronic warfare, or unintentional, such as high-tension line leakage. Megawatt wind turbines cause EMI and pose a hazard to air navigation. 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. EMI also affects consumer devices, such as cell phones, FM radios, television reception, and garage door openers. For air operations, EMI is a concern because it can disrupt navigation and communications equipment. There also have been reports of EMI affecting aircraft fuel systems, warning lights, and propulsion. Any of these disruptions could lead to loss of aircraft and life.

5.4.4 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. This is particularly dangerous at night when the flash can diminish the eye's adaptation to darkness. Partial recovery takes only a few minutes, but full recovery can take 40 to 45 minutes. Visible lasers, including low-powered legal laser pointers, are emerging as a safety concern for pilots. Visual interference with pilot performance due to lasers can result in temporary flash blindness, glare, disruptions, and distractions. These are most hazardous during critical phases of flight—landings, takeoffs, and emergency maneuvers. There is also concern about urban lighting that is not downward-directed, as well as the potential impacts of light-emitting diode, or "LED," lights on pilots who are training with night vision goggles.

5.4.5 Smoke, Steam, and Dust

Land uses that generate 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. Examples include dust from agricultural activities and thermal plumes from geothermal industries.

5.4.6 Drones/Unmanned Aircraft Systems

The use of drones near military airfields poses a serious flight safety hazard due to the potential for a mid-air collision between military aircraft and small- to medium-sized drones. The FAA maintains specific guidance about where drones (i.e., UAS) can be flown. Drone operations are not generally permitted within certain zones surrounding military bases. Additional restrictions are in place around airports and security-sensitive areas. For more information on drone use in and around DOD airfields, visit the FAA's website at: www.faa.gov/uas.

6 Land Use Authorities, Policies, Regulations, and Programs

6.1 Planning Authorities, Policies, Regulations, and Programs

6.2 Other Land Use Programs and Tools

6.3 Policy, Regulation, and Program Implementation

Successful AICUZ land use compatibility implementation is the collective responsibility of the Navy, state and local governments, and private sector and non-profit organizations. This chapter discusses federal, state, and local planning authorities, regulations, and programs that encourage compatible land use.

This AICUZ Study presents data to encourage cooperative land use planning between NASWI and surrounding communities so that future growth and development are compatible with the operational missions and operational effects on adjacent lands are minimized. Although ultimate control over land use and development surrounding NASWI is the responsibility of local governments and landowners, through the provision of information in this AICUZ Study, the Navy encourages local governments to plan for compatible development.

6.1 Planning Authorities, Policies, Regulations, and Programs

NASWI's AICUZ footprint is located in the unincorporated areas of Island and Skagit counties and the urban growth areas for the city of Oak Harbor and town of Coupeville. To determine land use compatibility, the Navy examined both existing and planned land uses near the airfield. Development and control of land outside of the base boundary are beyond the jurisdiction of the Installation Commanding Officer. Development of this land is regulated by federal, state, and local general land use planning, ordinances, and regulations.

> Military bases can make recommendations or advise local government and agencies on land use outside the fence, but development of the land is dictated by local land use planning, ordinances, and regulations.

The local land use practices of local jurisdictions can impact NASWI's mission and must be considered to manage development within the AICUZ footprint. Land use planning in Island and Skagit counties, Oak Harbor, and Coupeville directly influences the land area surrounding the airfield. Land use planning programs, comprehensive plans, policies, councils, and commissions for local jurisdictions with the potential to influence land use in the vicinity of NASWI are discussed in this section.

While comprehensive planning allows jurisdictions to consider the impacts of current and future development, zoning is the legal tool for implementing a land use plan. Zoning regulates land use, density, and the height of structures, and can prohibit the creation of other hazards for military operations, including smoke, radio interference, and glare.

6.1.1 Federal

The following are federal regulations and programs that provide NASWI the opportunity to guide development and land use within the vicinity of the base and the AICUZ footprint.

National Environmental Policy Act

Under the National Environmental Policy Act (NEPA), federal agencies, including the Navy, are required to consider the environmental impacts of any federal project that could significantly impact the environment. NEPA mandates full disclosure of the environmental effects resulting from proposed federal actions, approvals, or funding. Impacts of the action are documented in a Categorical Exclusion, Environmental Assessment, or EIS. The environmental impact review process provides an opportunity for the public and the Navy to comment on federal agency projects that may affect land use decisions on NASWI or in the surrounding area.

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

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

Housing and Urban Development Handbook 1390.4: A Guide to HUD Environmental Criteria and Standards Contained in 24 CFR Part 51

The *United States Department of Housing and Urban Development (HUD) Handbook 1390.4: A Guide to HUD Environmental Criteria and Standards Contained in 24 CFR Part 51* replaces *HUD Circular 1390.2: Noise Abatement and Control*. The circular established noise standards and polices for approving noise attenuation measures and HUD-assisted housing projects in areas with exposure to noise. Current HUD regulations described in Handbook 1390.4 set forth a discretionary policy to withhold funds for housing projects when noise exposure exceeds prescribed levels. The HUD regulations allow for new housing construction assisted or supported by HUD within a noise area of 65 DNL or less. In an effort to discourage development in areas with noise higher than 65 DNL, federal agencies, such as HUD, have implemented policies that require sound attenuation for construction within a 65- to 75-DNL noise area (e.g., dense wall material [concrete, brick], cavity partitions [airspace between two walls], acoustical blankets [insulation], double-paned windows, solid core wood doors). Development within an area exceeding a 75-DNL noise level is generally ineligible for loan assistance, but variances from this policy can occur based on regional interpretation and local conditions. HUD regulations include policies that prohibit funding for HUD-assisted projects sited in Clear Zones and APZs unless the project is compatible with the AICUZ. The approval of all mortgage loans from the Federal Housing Administration or the Veterans Administration is subject to the standards and polices of HUD noise regulations.

Navy

DOD AICUZ Program

The DOD began the AICUZ Program in the early 1970s to help government entities and communities anticipate, identify, and promote compatible land use and development near military installations. 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 military installation must work with the local community to encourage compatible development of lands adjacent to the installation. Under the AICUZ Program, the Navy has established guidelines that define noise zones and APZs surrounding NASWI. This AICUZ Study is the latest update to NASWI's AICUZ Program, and local governments are encouraged to incorporate the new AICUZ footprint in their land use planning, and development practices.

DOD Encroachment Partnering Program

Title 10, United States Code (U.S.C.) Section 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, for the purpose of limiting encroachment or use of the property that would be incompatible with the mission of the installation or place other constraints on military training, testing, and operations. Eligible entities include a state, a political subdivision of a state, or a private entity that has as its principal organizational purpose or goal the conservation, restoration, or preservation of land and natural resources, or a similar purpose or goal.

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

6.1.2 State of Washington

The following are state regulations and programs that provide NASWI the opportunity to guide development and land use within the vicinity of the base and the AICUZ footprint.

Department of Commerce

The Washington State Department of Commerce is the lead state agency charged with enhancing and promoting sustainable community and economic vitality in Washington. Through various programs, the Department of Commerce works with local governments, businesses, and civic leaders to strengthen communities, so all residents are able to thrive and prosper (Washington State Department of Commerce 2017). The department works across the state's key industry sectors, including agriculture and food manufacturing, clean technology, aerospace, forest products, life science and global health, information and communications technologies, maritime industries, and the military services and defense sector. Military installations in Washington are the state's second-largest direct public employer (Washington State Department of Commerce 2019).

Washington State Department of Commerce

For more information regarding the Department of Commerce visit www.commerce.wa.gov/

The Department of Commerce, through its Growth Management Services division, is responsible for providing guidance and resources to local governments to assist in meeting the requirements of the Growth Management Act. In 2015, the Washington State Legislature directed the Department of Commerce to study the effects of incompatible land use surrounding military installations within Washington State and best practices from other states for mitigating incompatible land use conflicts between local jurisdictions and neighboring military installations (Washington State Department of Commerce 2019). As part of this effort, the Department of Commerce, through a process of research, local government and military stakeholder engagement, and public outreach, developed the *Washington State Guidebook on Military and Community Compatibility* to provide technical guidance on compatible use planning projects (Washington State Department of Commerce 2019).

Washington State Growth Management Act

The Growth Management Act (RCW 36.70A.530) states: "Military installations are of particular importance to the economic health of the state of Washington and it is a priority of the state to protect the land surrounding our military installations from incompatible development."

The Washington State Growth Management Act (GMA; Revised Code of Washington [RCW] 36.70A.530, first adopted in 1990, requires fast-growing cities and counties to develop and update comprehensive plans to manage their population growth. At the state level, the Washington Department of Commerce provides technical assistance to local governments in meeting the requirements of the GMA and implementing their comprehensive plans. Based on the populations of Island and Skagit counties, both counties and all cities and towns within them are required to maintain and implement comprehensive plans in accordance with the GMA (RCW 36.70A.040) (MRSC 2020).

The GMA establishes the comprehensive plan as the primary tool to guide local land use and development. Comprehensive plans set forth a series of goals, objectives, policies, actions, and standards intended to guide decision-making by local government staff and elected officials. Required elements of local comprehensive plans include:

- Land Use;
- Housing;
- Capital Facilities Plan;
- Utilities;
- Rural Development (required for counties only)
- Transportation;
- Economic Development;
- Parks and Recreation; and
- Ports (mandatory for cities with annual maritime port revenues exceeding $60 million).

Comprehensive plans may also include optional elements: conservation, solar energy, recreation, subarea plans, and ports (for cities with annual maritime port revenues between $20 million and $60 million) (MRSC 2020).

The GMA notes the military's significant role in Washington's economy and declares a state priority to protect land surrounding military installations from incompatible development that would interfere with the installation's ability to carry out its mission requirements (RCW 36.70A.530). Local governments consider compatibility as they update or amend their comprehensive plans and development regulations. The GMA also establishes requirements for local governments to notify the Commanding Officer of installations within or adjacent to the border of its jurisdiction of the government's intent to amend its comprehensive plan or development regulations and request written recommendations to be considered in adoption of the amended plan or regulations (RCW 36.70A.530).

Washington Coastal Zone Management Program

> DEPARTMENT OF ECOLOGY State of Washington
>
> For more information regarding the Washington Coastal Zone Management Program, visit www.ecology.wa.gov

The federal Coastal Zone Management Act (CZMA) of 1972 establishes a federal-state partnership to manage use of coastal resources. Coastal states and territories develop state-specific coastal management programs to balance resource protection and coastal development needs. The Washington Coastal Zone Management Program, through a network of state laws and regulations, lays out the policy to guide the use, protection, and development of land and ocean resources within the state's coastal zone. The Washington Shoreline Management Act of 1971 defines the shorelines of the state and shorelands that are included in the state's Coastal Zone Management Program. Shorelands include areas extending landward for 200 feet from the ordinary high-water mark; floodways and areas 200 feet landward from floodways; and wetlands and river deltas associated with the streams, lakes, and tidal waters that are subject to the Shoreline Management Act (RCW 90.58.030). The state's Coastal Zone Management Program is administered by the Department of Ecology, which works with local governments to develop and implement local shoreline master programs that include policies and regulations to guide the use of the state's shorelines and shorelands.

Island County's Shoreline Master Program establishes goals and policies to regulate and manage activities occurring within the County's shoreline jurisdiction. These goals and policies address seven elements that cover broad aspects of shoreline management: economic development, recreation and public access, transportation, shoreline use, historic and cultural, conservation, and restoration (Island County n.d.). The program's goals and policies are implemented through the County's Shoreline Master Program Regulations and Procedures, which regulate shoreline uses and modifications and establish permit requirements. The County is in the process of developing an updated Shoreline Master Program in 2020.

6.1.3 Island Regional Transportation Planning Organization

> The IRTPO develops the regional transportation plan for Island County. For more information about the IRTPO, visit www.islandcountywa.gov

There are 15 regional transportation planning organizations (RTPOs) in Washington that provide planning support to their member governments. RTPOs are voluntary organizations of local governments for the purpose of coordinating transportation planning and are formed under the authority of the GMA. They develop regional transportation plans, implement regional transportation improvement programs, and participate in statewide multimodal transportation planning efforts (Island County 2020[a]). NASWI is located in the Island Regional Transportation Planning Organization (IRTPO), which includes Whidbey and Camano islands and local communities in Island County.

The IRTPO develops the regional transportation plan for Island County. The plan focuses on regional multimodal transportation networks and supports local comprehensive plan goals and objectives. The IRTPO functions as a forum for County government; local governments, including the City of Oak Harbor and Town of Coupeville; and the Navy to coordinate on planning decisions and investments related to transportation.

6.1.4 Island County

The lands to the north, east, and southwest of NASWI are in the unincorporated area of Island County and, therefore, the development and use of these lands are controlled by the County. The local planning authorities in Island County are the Board of County Commissioners, the Planning Commission, and the Planning and Community Development Department, which guide land use and development in the county.

The Board of County Commissioners is made up of three elected commissioners who represent the three districts within Island County. Under the authority of the GMA, which requires jurisdictions to develop and implement comprehensive plans accounting for the next 20 years of population growth, the Board of County Commissioners adopted the latest update of the Island County Comprehensive Plan on December 13, 2016. In accordance with State requirements, the plan provides the policy basis for the County's land use planning program and guides land use decisions within the county. The plan is also a tool for coordinating land use planning efforts between local jurisdictions, service providers, and state and federal agencies (Island County 2016[a]).

The Planning Commission is composed of nine volunteers who are appointed by the Board of County Commissioners. The Planning Commission makes recommendations to the Board in matters concerning growth and development in unincorporated parts of the county. The Planning Commission considers comprehensive plan amendments and updates, regulatory changes, proposed zoning changes, interjurisdictional planning efforts, economic development matters, and other proposed land use and development changes.

For more information regarding the County's Comprehensive Plan and land use policies, visit www.islandcountywa.gov

The Planning and Community Development Department oversees, manages, and regulates land use and development within unincorporated areas of the county in order to protect the health, safety, and welfare of county residents. The department is responsible for long-range comprehensive planning, maintaining and implementing the zoning code, implementing Island County's Shoreline Master Program, land use permitting, and building code enforcement. The department reviews building permits and development proposals submitted by property owners to ensure they comply with applicable federal, state, and County regulations.

Island County uses zoning ordinances and other land use controls to implement the goals and objectives of the Island County Comprehensive Plan. The County's zoning code includes regulations and procedures for the Shoreline Master Program, the Ebey's Landing National Historical Reserve Design Review and Community Design Standards, and defines urban growth areas and joint planning areas for Oak Harbor and Coupeville. The zoning code also establishes land use standards for areas within APZs (Section 17.03.180(Z)), including prohibiting subdivisions in most cases and establishing permitted land uses within the APZs.

In accordance with the GMA, the County has established a growth management strategy in the Island County Comprehensive Plan that directs future development to several types of designated planning areas, including:

- Urban Growth Areas (UGAs) – As required by the GMA, UGAs are areas that are sufficient to accommodate 20 years of projected future urban growth. The boundaries of a UGA are established by the County in collaboration with the associated municipality based on population projections, land capacity, availability of public facilities to serve the area, and the fiscal impacts of development in the area. Urban development that cannot be accommodated within existing city limits will be directed to the adjacent UGA. The County and respective municipalities have designated UGAs for Oak Harbor and Coupeville (Figure 6-1). The UGA for Oak Harbor includes land that is currently outside of the incorporated city limits, while the boundaries of Coupeville's UGA are the city limits.
- Joint Planning Areas (JPAs) – Immediately outside of the UGA for Oak Harbor, the City and the County have designated a JPA, which provides an area for planning for long-term urban growth beyond the 20-year planning period. Two types of overlay districts are designated within the JPA, Potential Growth Areas and Areas of Long-Term Rural Significance. Potential Growth Areas are areas that will be considered first for any future expansions of the UGA, while Areas of Long Term Rural Significance are areas that will be protected from development to the extent possible and will be considered last for future UGA expansions (Island County 2016[a]).
    - The JPA around the town of Coupeville was revoked during the 2016 update of the County's comprehensive plan. Development outside of the town limits is primarily reviewed and permitted under the Ebey's Landing National Historic Reserve joint planning process (Island County 2016[a]).
- Rural Areas of More Intensive Development (RAIDs) – The RAID designation allows development, redevelopment, or infill development of unincorporated areas of the county outside of UGAs at greater densities than typically allowed in rural districts. Island County has three types of RAIDS (residential, non-residential, and mixed use). The boundaries of these RAIDs were established around existing areas of more intensive rural development as of 1990 and form logical boundaries within which more intensive rural uses will be contained. These areas are designated primarily to preserve the character of existing neighborhoods and to allow additional subdivision of parcels and development subject to applicable County regulations (Island County 2016[a]).

Designated UGAs, JPAs, and RAIDs within the AICUZ footprints for Ault Field and OLF Coupeville are discussed in detail in Section 7.2.3, Future Land Use Surrounding NASWI.

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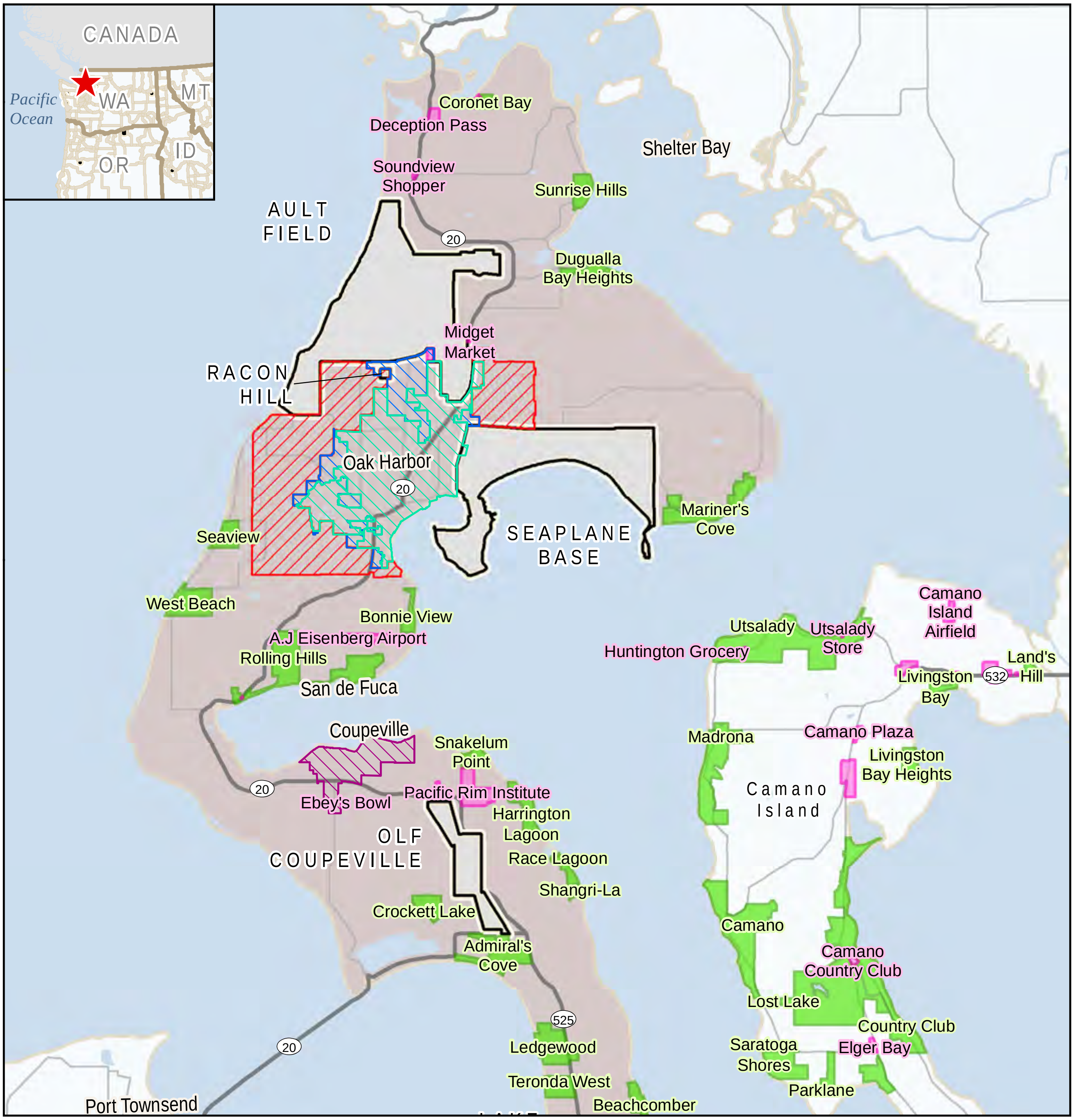

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Legend

- U.S. and State Highway
- Major Road
- Installation Area
- Waterbody
- Whidbey Island
- Oak Harbor Joint Planning Area
- Coupeville Urban Growth Area
- Oak Harbor Incorporated Urban Growth Area
- Oak Harbor Unincorporated Urban Growth Area
- Non-Residential RAIDS
- Residential RAIDS

Figure 6-1
Designated Planning Areas for Future Growth in Island County
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2013; ESRI 2020, 2012, 2016; Island County 2014, 2020; Washington State Department of Ecology 2014.

6.1.5 City of Oak Harbor

The lands southeast of NASWI are in the incorporated area of the city of Oak Harbor, and development and use of these lands are controlled by the City of Oak Harbor's land use policies and plans. This area includes lands within the incorporated city limits. Unincorporated areas within the city's urban growth area fall under the planning jurisdiction of Island County.

The local planning authorities for the City of Oak Harbor are the City Council, Planning Commission, and Development Services Department. The City Council is made up of seven members, including the mayor. The Planning Commission includes seven members who are appointed by the mayor and approved by City Council. The Planning Commission serves in an advisory capacity and makes recommendations to the Mayor and City Council on proposed land use and development activities, including preliminary development plans and requests for rezoning that require a public hearing and legislative decisions, such as amendments to land use regulations, the comprehensive plan, or subarea plans.

The Development Services Department is responsible for updating and implementing the City's comprehensive plan and administering development regulations and standards and building codes. The department includes the Planning Services Division and the Building Division. The City's current comprehensive plan, Oak Harbor 2036, was adopted in 2016. The comprehensive plan is the foundational policy document that guides growth and development in the city for the next 20 years and beyond, in accordance with the community's vision for the future. The plan establishes planning policies to guide City actions and provides a framework for collaboration by City departments, community organizations, and other stakeholders on land use planning efforts. Chapter 14 of the comprehensive plan summarizes policies that support the mission of NAS Whidbey Island and the military community in Oak Harbor. These include land use policies such as discouraging encroachment of incompatible land uses in noise zones and APZs and requiring noise abatement construction standards in noise zones (City of Oak Harbor 2016).

The goals and policies of the comprehensive plan are implemented through the City's zoning code, which includes land use and development regulations and standards. The City's Aviation Environs Overlay Zone ordinances (Section 19.50.010, et seq.) were established to protect public health, safety, and welfare by regulating development and land use within noise sensitive areas and APZs, to ensure compatibility between NASWI and surrounding land uses, and to protect the installation from incompatible encroachment. The overlay zone applies additional standards and requirements to properties in an underlying zoning district to promote compatible land use and development. The overlay zone includes subdistricts for APZ I, APZ II, areas within 1,000 feet of either APZ, areas between the 60-dB and 65-dB DNL noise contours, areas between the 65-dB and 75-dB DNL noise contours, and areas within the 75-dB DNL and higher noise contours (Section 19.50.040).

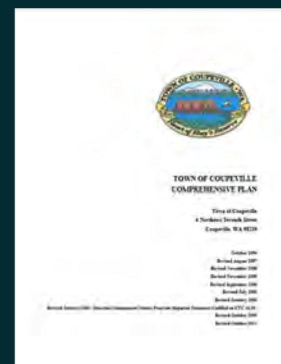
For more information regarding the City of Oak Harbor's Comprehensive Plan and land use policies, visit www.oakharbor.org/dev

The City collaborates with Island County to plan for future growth of Oak Harbor and annexation of land within the city's UGA and JPA. The City's comprehensive plan establishes land use categories in the UGA to encourage desirable land use patterns that meet the City's development standards (City of Oak Harbor 2016).

6.1.6 TOWN OF COUPEVILLE

Coupeville is located approximately 2 miles northwest of OLF Coupeville. While land surrounding the OLF is within unincorporated Island County, the 2021 AICUZ footprint for OLF Coupeville does overlap lands within the planning jurisdiction of the Town of Coupeville.

Local planning authorities for the Town of Coupeville are the Town Council; several boards and commissions, including the Planning Commission, Historic Preservation Commission, and Trust Board for Ebey's Landing National Historic Reserve; and the Planning Department. The Town Council is the policy-making board of the Town and includes five elected members. The Town's boards and commissions that play a role in land use and development planning are described briefly below:


TOWN OF COUPEVILLE
COMPREHENSIVE PLAN

For more information regarding the Town of Coupeville's Comprehensive Plan and land use policies, visit https://townofcoupeville.org

- The Planning Commission is made up of five members. The commission is responsible for the review and recommendations of: amendments to the Town's Comprehensive Plan; amendments to Title 16, Coupeville Development Regulations; amendments to the Shoreline Master Program; request for parcel-specific zoning change; planned unit development overlay districts; preliminary long subdivisions; shoreline development permits, shoreline conditional use permits, shoreline variances; Conditional use permits; variances; and other actions as requested or remanded by the town council.
- The Historic Preservation Commission is made up of seven appointed members. The commission works with the Town, Island County, and the Ebey's Reserve Trust Board staff to process applications for Certificates of Appropriateness for properties located within Ebey's Landing National Historical Reserve.
- The Trust Board for Ebey's Landing National Historic Reserve is made up of nine members, including three appointed by the Town. The Trust Board is responsible for management of Ebey's Landing National Historical Reserve, according to adopted interagency plans and agreements.

The Town's Planning Department is responsible for supporting the Planning Commission and Historic Preservation Commission. The department also administers the Town's policies and regulations related to land use, development, and building; and completes long-range planning for the town through updates of Coupeville's comprehensive plan.

The current Town of Coupeville Comprehensive Plan was updated in 2011. The plan guides the Town's regulatory and administrative actions related to land use and development and establishes goals and policies to support the community's vision of maintaining Coupeville as a town that succeeds in preserving and building upon its rich history, natural setting, and small town atmosphere (Town of Coupeville 2011). The plan includes goals and policies related to land use; housing; transportation; historic preservation; parks, recreation, and open space; economic stability; and other areas as required by the GMA. The plan mentions the presence of Ault Field and OLF Coupeville but does not include policies related to compatible land uses within the AICUZ footprint of the OLF (Town of Coupeville 2011).

The Town's development regulations establish zoning districts and standards for development and land use in areas within the Town's planning jurisdiction, including design standards for areas within Ebey's Landing National Historical Reserve. The Town has not developed regulations or overlay districts related to aircraft operations at OLF Coupeville.

The Town has established future land use categories for future growth within the UGA (within the town limits) in its 2011 comprehensive plan. These categories are equivalent to the Town's zoning districts. As noted in Section 6.1.4, Island County, urban development outside of the town limits is primarily reviewed and permitted under the Ebey's Landing National Historic Reserve joint planning process. The Town will coordinate any future expansion of the UGA into unincorporated areas of the county through an interlocal agreement with Island County (Town of Coupeville 2011).

6.1.7 Skagit County

The western boundary of Skagit County is approximately 5 miles west of Ault Field. The 2021 AICUZ footprint for Ault Field overlaps unincorporated areas of the county south of the town of La Conner and some parts of south Fidalgo Island.

For more information regarding the County's Comprehensive Plan and land use policies, visit www.skagitcounty.net

The local planning authorities for the county are the Board of County Commissioners, Planning Commission, and Planning and Development Services Department. The Board of County Commissioners is made up of three elected commissioners who serve as the County's legislative authority. The board is responsible for adopting, amending, and repealing all County ordinances and oversees the planning and zoning of unincorporated areas of the County. The Planning Commission is made up of nine appointed members. The Planning Commission is the County's primary citizen advisory board on land use policy and regulations and makes recommendations to the Board of County Commissioners.

The Planning and Development Services Department is responsible for land use planning and permitting; code enforcement; and implementation of strategies, policies, and regulations to guide future growth and development in unincorporated parts of the county (Skagit County Planning and Development Services 2019). The County's current comprehensive plan was adopted on June 30, 2016 and has been amended several times in the following years. The comprehensive plan establishes goals and policies related to land use and future growth as well as housing, transportation, capital facilities, and other areas, as required by the GMA (Skagit County 2016). Due to the fact that most of the county is outside of the AICUZ footprint for NASWI, the comprehensive plan does not identify goals or policies related to aircraft noise or accident potential. The County implements the goals and policies of the comprehensive plan primarily through its zoning code.

Like Island County, Skagit County has identified UGAs for incorporated cities and towns. Most new growth in the county will be directed to UGAs (Skagit County 2016). Based on historic development patterns and projected needs, the UGA for La Conner, which is north of the 2021 AICUZ footprint for NAS Whidbey Island, follows the boundary of the town and would not overlap the AICUZ footprint. Skagit County has not established future land use designations.

6.1.8 San Juan County

San Juan County is made up of the San Juan Islands, a cluster of over 400 islands located northwest of Island County in the Salish Sea. The 2021 AICUZ footprint for Ault Field (the 60 dB DNL noise contour) overlaps James Island Marine State Park, which lies to the east of Lopez Island and Decatur Island, and three exposed, uninhabited bedrock formations to the south, Bird Rocks, which are part of the San Juan Islands Wilderness and managed by the United States Fish and Wildlife Service (USFWS). These islands are protected for conservation uses and limited recreation.

The local planning authorities for the county are the County Council, Planning Commission, and Community Development Department. The County Council, San Juan County's legislative authority, includes three elected members. The County Council is responsible for adopting, amending, and repealing all County ordinances, including development regulations, and adopting updates of the County's comprehensive plan. The Planning Commission includes nine members who are appointed by the County Council. The commission advises the council on land use and planning decisions.

For more information regarding San Juan County's Comprehensive Plan and land use policies, visit https://www.sanjuanco.com/510/Comprehensive-Plan

The Community Development Department is responsible for land use permitting, long-range planning, and enforcement of development regulations and building codes in unincorporated parts of the county. The County was in the process of updating its comprehensive plan as of July 2020. The updated plan will include the County's goals and policies related to land use and future growth, transportation, housing, utilities, and other areas, as required by the GMA (San Juan County 2020[a]). The land use element of the comprehensive plan establishes an airport overlay district for publicly-owned airports in the county but does not include any overlay district or policies addressing land use in areas where residents may be exposed to noise levels as a result of aircraft operations from NASWI (San Juan County 2020[b]). The County implements the goals and policies established in the comprehensive plan through its land use and development and unified development codes.

6.2 Other Land Use Programs and Tools

6.2.1 Zoning Regulations

In Washington State, counties are fully zoned. Through zoning regulations, counties are authorized to create zoning districts that permit or prohibit certain property uses, construction standards, and development densities.

6.2.2 Readiness and Environmental Protection Integration

The National Defense Authorization Act of 2004 granted the DOD the authority to enter into agreements (or partnerships) with private conservation organizations or state and local governments to establish buffers around military training and testing areas to restrict incompatible land use. Funding for the compatible land use efforts is provided to the DOD by Congress under the Readiness and Environmental Protection Integration (REPI) Program. REPI Program funding will support service agreements that, as authorized by 10 U.S.C. §2684a, seek to:

(1) Limit any development or use of property that would be incompatible with the mission of an installation; or
(2) Preserve off-installation habitat to relieve current or future environmental restrictions on military operations.

The REPI Program helps military installations sustain operational capabilities and ensure the future use of military training areas. Under the REPI Program, the DOD provides funding to military services in support of cost-sharing partnerships with non-federal organizations to purchase easements or acquire an interest in land. Land acquisition initiatives must be negotiated with a willing seller. Through partnerships, military services work with local and state agencies or conservation organizations to identify areas where land acquisition or conservation easements would be mutually beneficial for all parties. The partnership obtains property interest with the goal of controlling growth, preserving open space, and ultimately preventing future encroachment. The protected land obtained through REPI Program funding is not owned by the military or used for military training or testing. To date, over $12 million has been spent in Island County executing the REPI Program.

6.2.3 Practical Guide to Compatible Civilian Development Near Military Installations

The DOD's Office of Economic Adjustment released a Practical Guide to Compatible Civilian Development Near Military Installations to highlight opportunities that local governments, states, and DOD representatives can take to promote compatible land use around military installations (DOD Office of Economic Adjustment 2005). The Guide describes a variety of strategies that can be employed by military installation commanders, local government officials, planners, community members, and state officials to address encroachment by promoting the use of land surrounding a military installation in a way that is compatible with the military's mission. The Guide focuses on approaches or best practices that an installation and surrounding communities can implement to initiate land use compatibility.

6.2.4 Capital Improvement Program

Capital Improvement Program (CIP) projects, such as the extension of potable water lines or transmission lines, road paving and/or improvements, right-of-way acquisition, and school construction/renovation, can encourage new development to under-served areas. CIPs direct future growth patterns and ensure that the areas near military installations are developed in accordance with the AICUZ Program's recommended land use guidelines. Jurisdictions fully planning under the GMA, including Island and Skagit counties, are required to include a capital facilities plan element in their comprehensive plan that includes an inventory of existing facilities and a forecast of future capital facility needs (RCW 36.70A.070(3)). Local governments can coordinate CIP projects to avoid extending infrastructure into or near noise zones or APZs.

6.2.5 Transfer of Development Rights Programs

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

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

6.2.6 Purchase of Development Rights Programs

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

6.2.7 Real Estate Disclosure

Real estate disclosures allow prospective buyers, lessees, or renters of property in the vicinity of military operations areas to make informed decisions regarding the purchase or lease of property. Disclosure of noise and safety zones is a crucial tool in protecting and notifying the community about expected exposure to aviation noise and the locations of APZs, subsequently reducing frustration and criticism by those who were not adequately informed prior to purchase of properties within impact area. Since 1992, Island County has required property owners in airport environs mapped impacted areas to provide a disclosure to potential buyers or lessees that states:

> The property at ______ is located within airport environs mapped impacted area. There are currently five (5) active airport facilities in Island County. The Oak Harbor Airpark, the South Whidbey Airpark, and the Camano Airpark are general aviation facilities and are identified on the attached map. Ault Field and [OLF] Coupeville are tactical military jet aircraft facilities and are also identified on the attached map. Both Ault Field and [OLF] Coupeville are used for field carrier landing practice (FCLP) purposes. Practice sessions are routinely scheduled during day and night periods.
>
> Property in the vicinity of Ault Field and [OLF] Coupeville will routinely experience significant jet aircraft noise. As a result airport noise zones have been identified in the immediate area of Ault Field and [OLF] Coupeville. Jet aircraft noise is not, however, confined to the boundaries of these zones.
>
> Additionally, the noise generated by the single flyover of a military jet may exceed the average noise level depicted by the airport noise zones and may exceed 100 [dBA].
>
> More specific information regarding airport operation and aircraft noise can be obtained by calling the Community Planning Liaison Office at NAS Whidbey Island and the Island County Planning and Community Development Department (Island County Code of Ordinances Section 9.44.050).

The City of Oak Harbor also established a noise disclosure ordinance in 1992 requiring property owners to notify prospective buyers or lessees if a property is located within the greater than 60-dB DNL noise contours (Oak Harbor Municipal Code Section 6.90.010). The noise disclosure ordinance was amended in 2002. The notice that must be provided to prospective buyers or lessees states:

> The property as described below is located within a designated noise zone for NAS Whidbey Island. Persons on the premises may be exposed to a significant noise level as a result of airport operations. In addition, Oak Harbor has placed certain restrictions on construction on property within the noise zones. Before purchasing, renting, or leasing the above property, you should review those regulations to determine the restrictions placed on the subject property, if any (Island County Code of Ordinances Section 9.44.050).

The Town of Coupeville does not have a codified or established noise disclosure program. As shown on Figures 4-2 and 4-4, the town of Coupeville is largely outside the area of noise impact. Southern portions of the town, including residential areas and Coupeville High School, are located within the 65 to 69-dB DNL contour range.

6.3 Policy, Regulation, and Program Implementation

From the inception of the AICUZ Program, a key component has been the participation of willing partners from state and local government. Communication and collaboration are key principles of the AICUZ Program and help ensure compatibility between the military mission, public safety, and economic development. Figure 6-2 highlights the key steps taken by the DOD and state and local government to study noise and safety at NASWI and implement policies, regulations, and programs to protect the health and safety of the citizens that are around the installation, while maintaining the viability of the mission and the ability to evolve and adapt mission requirements as necessary to meet the current needs.

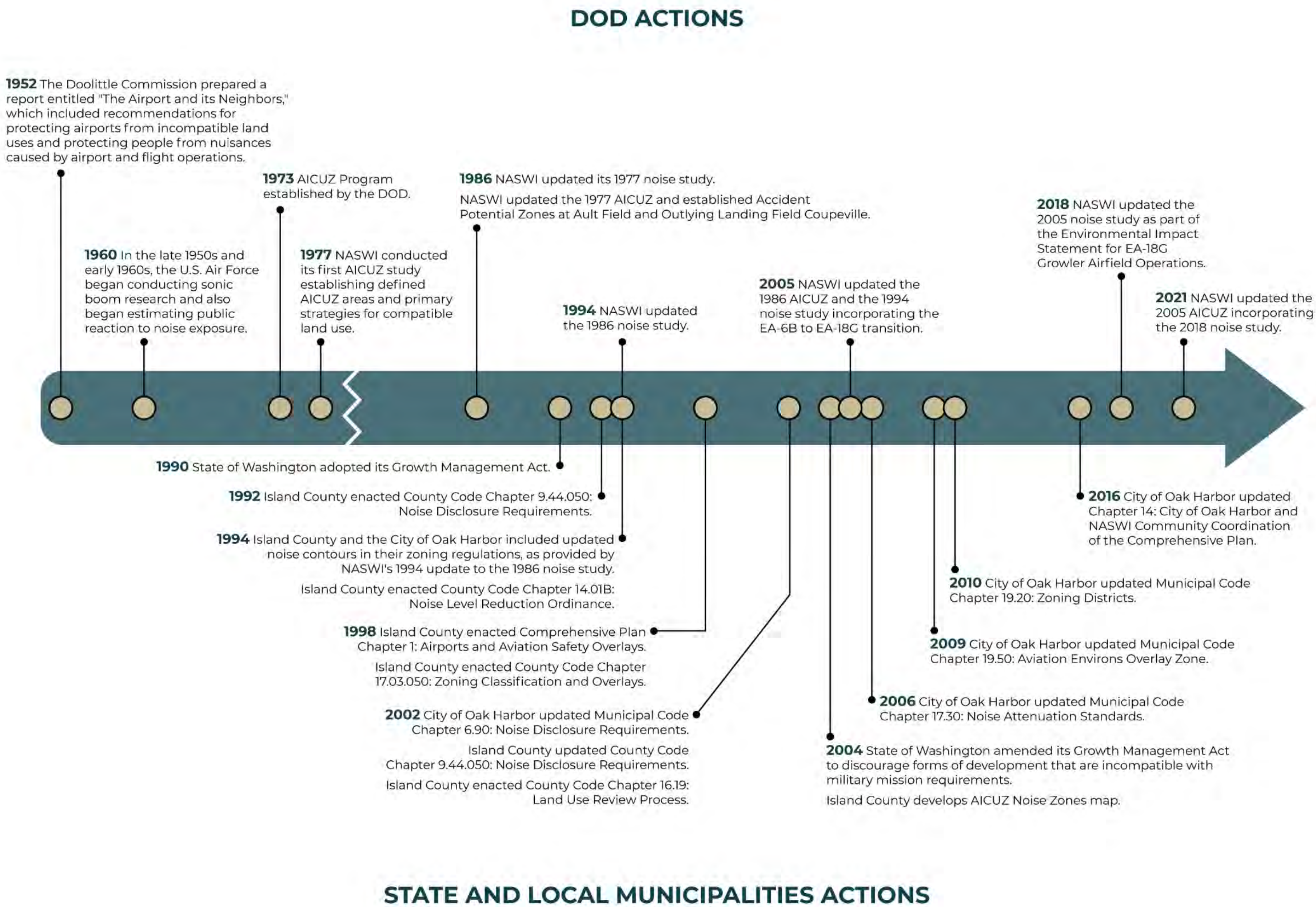


FIGURE 6-2 AICUZ IMPLEMENTATION TIMELINE

7 Land Use Compatibility Analysis and Recommendations

7.1 Guidelines and Classifications

7.2 Land Use Compatibility Analysis

7.3 NAS Whidbey Island AICUZ Study Recommendations

The information presented in this chapter of the AICUZ Study is intended for consideration by NASWI, government entities at the city, county, and state levels, surrounding communities, and other interested groups and interested stakeholders. The purpose of this chapter is to accurately describe the impact from and on Navy operations in order to provide local governments with the tools to ensure long-term compatibility between local land development goals and the Navy's continuing operation at Whidbey Island. These AICUZ Study recommendations will continue to advance the goal, to achieve compatibility between air installations and the community by encouraging compatible land uses that safeguard the installation's operational capabilities. Implementation of the recommendations is achieved over time through partnerships between NASWI and community stakeholders.

The AICUZ footprint is the area impacted by military operations, and generally consists of land within the 65 dB DNL and greater noise contours and APZs. Within the AICUZ footprint, the Navy seeks to ensure compatibility with local land use plans by clearly identifying areas where Navy activity may impact desired development. Land use compatibility guidelines provided in this AICUZ provide a useful framework for this analysis, but ultimately local governments must make determinations based on a variety of considerations. These guidelines are offered to inform local governments as they consider zoning and development choices for areas impacted by military operations. The AICUZ footprint for NASWI, including Ault Field and OLF Coupeville, is the basis for the land use compatibility analysis.

The AICUZ Program, combined with the guidance and recommendations in this AICUZ Study, are the fundamental tools necessary for the planning process.

The AICUZ footprint for Ault Field (Figure 7-1) and OLF Coupeville (Figure 7-2) reflects DNL contours and APZs based on projected aircraft operations discussed earlier in this AICUZ Study. The AICUZ boundary shown is the area contained within Noise Zone 2 (65 to <75 dB DNL) and Noise Zone 3 (≥75 dB DNL), as well as APZs (Clear Zone, APZ I, and APZ II) of the air installation. The Navy recommends that the noise contours and APZs presented in this AICUZ Study be adopted into individual county and municipal planning studies, regulations, and processes to best guide compatible development around the installation.

7.1 Guidelines and Classifications

While local conditions vary considerably, federal guidelines state that certain land uses are discouraged within the APZs and noise zones of active military airfields. The Navy has developed land use compatibility recommendations for APZs and noise zones to foster land use compatibility. These recommendations, found in OPNAVINST 11010.36C, serve as guidelines for compatible land use around military air installations. The guidelines recommend that noise-sensitive land uses (e.g., houses, churches, schools) be placed outside noise zones, and that people-intensive uses (e.g., apartments, theaters, churches, shopping centers, sports arenas) should be placed outside APZs. The Navy's compatibility recommendations are presented in Appendix B.

OPNAVINST 11010.36C Recommendations

Noise-sensitive land uses (e.g., houses, churches, schools) should be placed outside noise zones.

People-intensive uses (e.g., apartments, theaters, churches, shopping centers) should be placed outside APZs.

7.1.1 Suggested Land Use Compatibility for Noise

As discussed in Section 4.1, Noise Metrics, DNL metrics present reliable measures of community sensitivity to aircraft noise. It is important to note that the noise contours described in Chapter 4, Aircraft Noise, are not precise representations of noise perceived by individuals. A number of factors can influence the propagation of, and reaction to, noise, including geographic features, weather, and the receiver's perception of the source. It is noted that a portion of the population will be annoyed even by the lower levels of noise in Noise Zone 1. For land use planning purposes in AICUZ studies, noise exposure areas are divided into three noise zones, based on DNL levels. Noise Zone 1 (<55 to 64 dB DNL) is an area of low or no noise exposure. Noise Zone 2 (65 to 74 dB DNL) is an area of moderate noise exposure where some land use controls are recommended. Noise Zone 3 (75 to 85+ dB DNL) is the area of highest noise exposure where the greatest degree of compatible land use controls are recommended. In addition to noise zones, areas of concern may be defined where noise levels are not normally considered to be objectionable (less than 65 dB DNL), but land use controls are recommended in that particular area. The Navy's compatibility recommendations for noise are presented in Appendix B.

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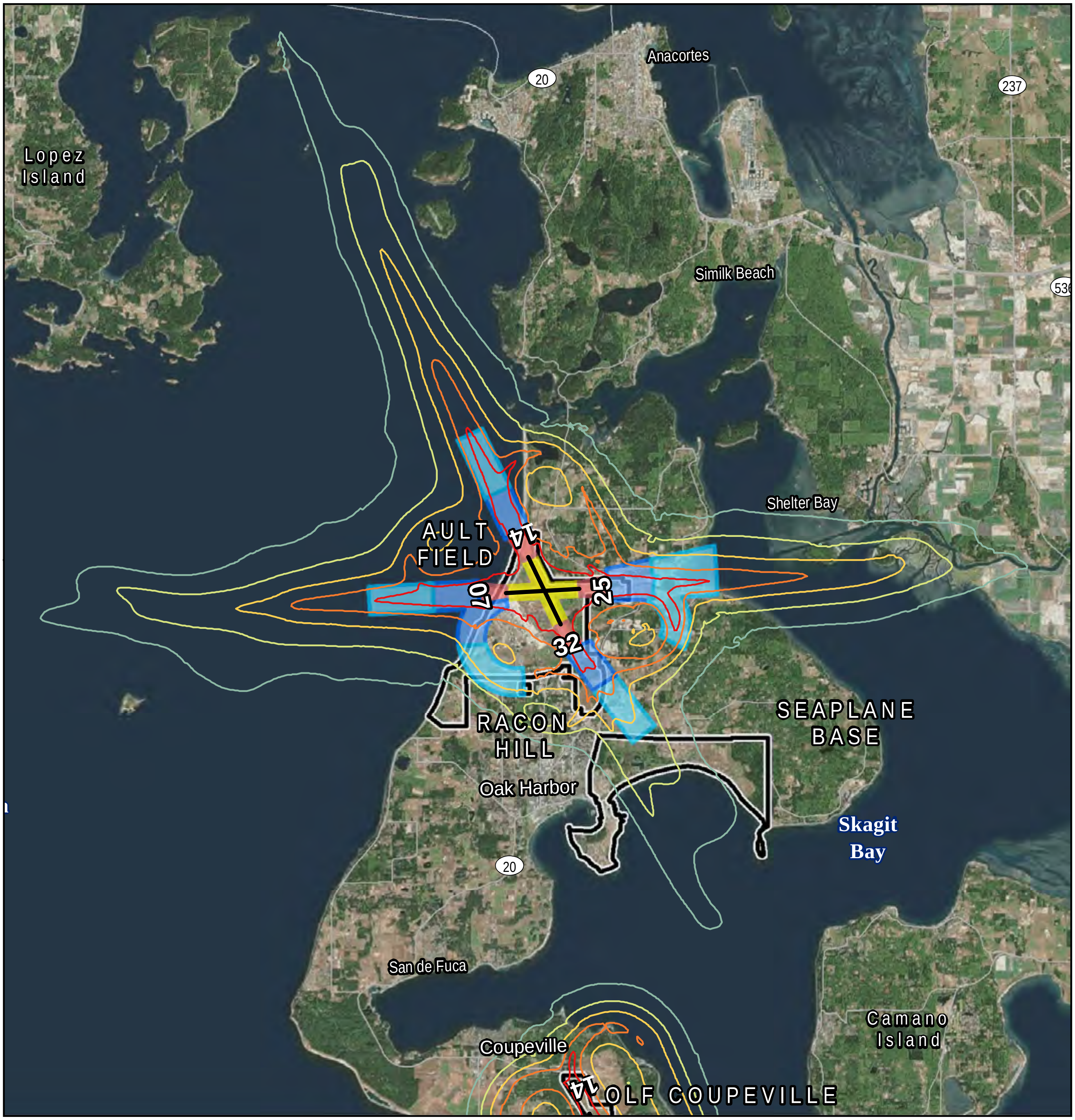


0 4 Miles

Legend

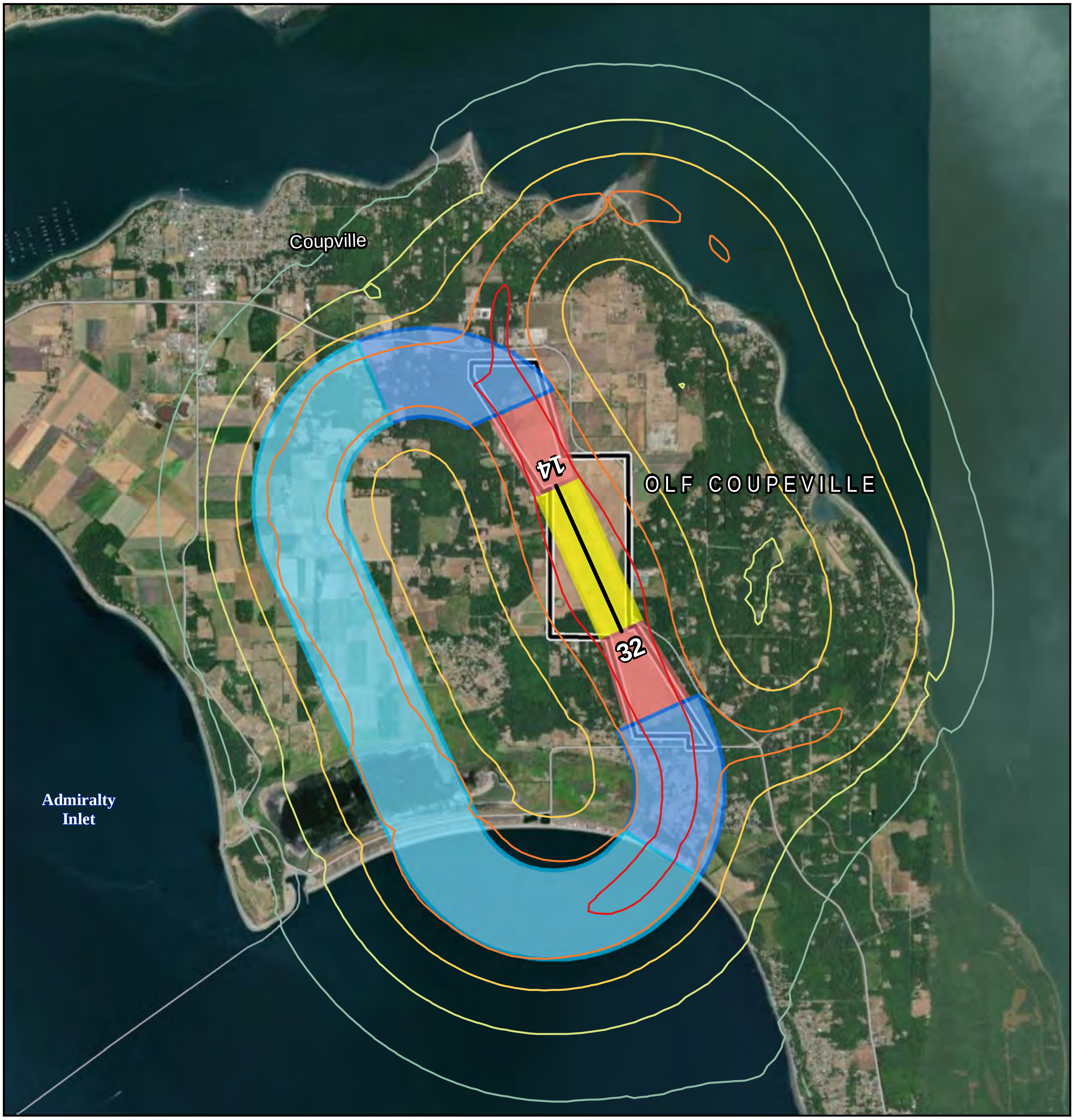
Highway
Runway
Installation Area

Noise Contour
65 dB DNL
70 dB DNL
75 dB DNL
80 dB DNL
85 dB DNL

Accident Potential Zones (APZs)
Primary Surface
Clear Zone
APZ I
APZ II

Figure 7-1
2021 AICUZ Footprint, Ault Field
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.



0 1 Miles

Legend

- Highway
- Runway
- Installation Area

Noise Contour

- 65 dB DNL
- 70 dB DNL
- 75 dB DNL
- 80 dB DNL
- 85 dB DNL

Accident Potential Zones (APZs)

- Primary Surface
- Clear Zone
- APZ I
- APZ II

Figure 7-2
2021 AICUZ Footprint, OLF Coupeville
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

7.1.2 Suggested Land Use Compatibility for Accident Potential Zones

For land use planning purposes, the Navy's recommended land use compatibility guidelines for Clear Zones and APZs are shown in Appendix B.

7.2 Land Use Compatibility Analysis

This section addresses land use compatibility within aircraft noise zones and APZs by examining existing and planned land uses near NASWI. The AICUZ footprint is the basis for the land use compatibility analysis. As previously noted, NASWI's AICUZ footprint is located in unincorporated areas of Island and Skagit counties and within the jurisdictional boundaries of the city of Oak Harbor and town of Coupeville (Figures 7-1 and 7-2). Therefore, land use within the off-installation AICUZ footprint is under the jurisdiction of those governments.

The land use compatibility analysis for this AICUZ Study is based on the Navy's land use compatibility guidelines, which are presented in Table 7-1. Land use patterns and zoning in the vicinity of NASWI, along with the land use compatibility assessment, are presented below.

7.2.1 Existing Land Use Surrounding NASWI

"Land use" describes the management of land and the extent to which it has been modified. Some typical uses found in communities include residential, commercial, industrial, and rural and agricultural areas. Land use is fundamental to the physical form of a county and its cities, and is a key component of the comprehensive plans, which are the primary policy documents that guide local land use and development in Washington State. Existing land uses in the vicinity of NASWI were evaluated using data from Island County, City of Oak Harbor, Town of Coupeville, and the State of Washington's Geospatial Open Data Portal. Parcel data are used to identify existing land uses to ensure an actual account of land use activity regardless of conformity to zoning districts or designated land use.

Ault Field

Ault Field is located in unincorporated Island County just north and outside of the city of Oak Harbor. Existing land use within the AICUZ footprint for Ault Field is shown in Table 7-1 and Figure 7-3. As shown in the table, the majority of land off-base that is within the AICUZ footprint (10,618 acres or 68 percent of the total acreage in the AICUZ footprint) is rural. This includes Rural Agriculture, Rural Forest, Rural Residential, Rural Service, and Rural Village uses. These land uses are primarily in unincorporated areas of Island County north, east, and south of the base. Rural residential areas are located on the shoreline of Skagit Bay and along the northern shoreline of the island outside Deception Pass State Park. Rural Village uses are also located near the northern shoreline of the island adjacent to the state park. Agriculture, Open Space, and Parks And Recreation uses also cover large land areas within the AICUZ footprint, reflecting the planning efforts of the County and City of Oak Harbor to maintain and support agricultural and rural land uses, outdoor recreation, and a small-town atmosphere.

Within Ault Field's AICUZ footprint, more intensive land uses are concentrated south of the base in the city of Oak Harbor. Parcels designated for mixed-use development are located in the northern and western parts of the city. The Mixed-Use area in the northern part of the city includes developed commercial uses and vacant land. The area in the western part of the city is primarily developed with residential uses. Commercial uses in the urban core of Oak Harbor are concentrated along Route 20, Oak Harbor Street, and Pioneer Way. Broad tracts of residential land occur east and west of Route 20 and public facilities land uses, including schools, are located throughout the city.

Federal land within the AICUZ footprint includes the Seaplane Base, which is home to residential and community support facilities for the Navy. In Skagit County, land within the AICUZ footprint is primarily used for agriculture; however, low-density residential areas and a resort and marina are located within the AICUZ footprint along the Skagit River and on Fidalgo Island. Northwest of Ault Field, in San Juan County, land within the AICUZ footprint includes James Island State Marine Park and Bird Rocks, which are part of the San Juan Islands Wilderness and managed by the USFWS. These areas are used for primarily for conservation and limited recreation and are shown as parks and recreation uses on Figure 7-3 and in Table 7-1.

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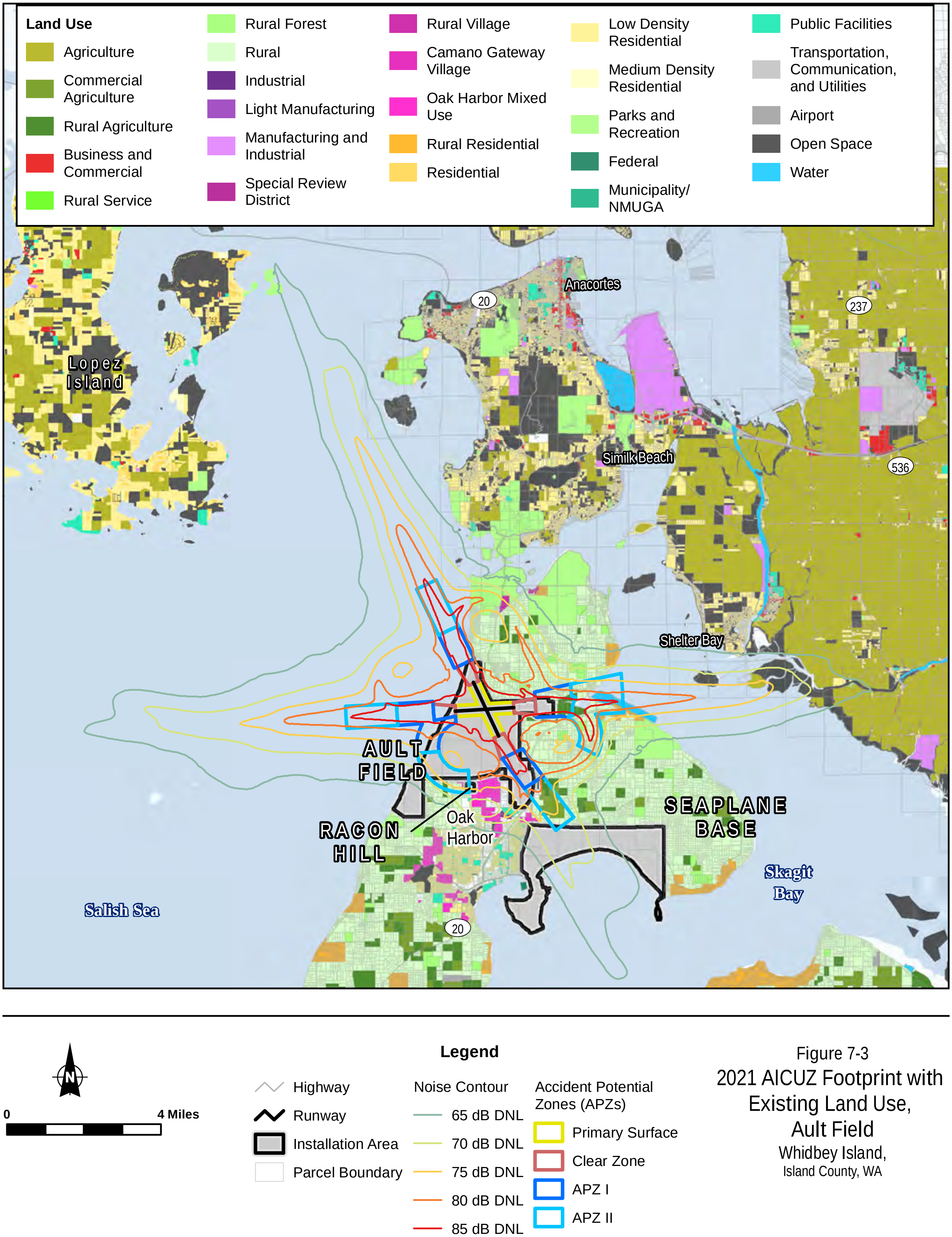

Figure 7-3
2021 AICUZ Footprint with Existing Land Use, Ault Field
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Ecology and Environment 2020; Washington State GIS 2018; Island County 2012.

TABLE 7-1 EXISTING LAND USES WITHIN THE AICUZ FOOTPRINT, AULT FIELD (ACRES)

LAND USE	ACCIDENT POTENTIAL ZONES[1]			NOISE LEVELS				
				NOISE ZONE 2		NOISE ZONE 3		
	CLEAR ZONE	APZ I	APZ II	65 TO 69 dB DNL	70 TO 74 dB DNL	75 TO 79 dB DNL	80 TO 84 dB DNL	85 TO 89 dB DNL
Agriculture	-	-	-	553	42	41	-	-
Auto/Industrial Commercial	-	-	43	<1	29	39	19	-
Business and Commercial	-	-	-	<1	-	-	-	-
Commercial Agriculture	-	-	219	48	102	147	-	-
Community Commercial	-	-	-	27	25	-	-	-
Federal	2	10	5	9	4	9	10	10
High-Density Residential	-	-	-	6	1	-	-	-
Highway Corridor Commercial	-	-	-	11	10	-	-	-
Industrial	-	-	-	-	16	4	-	-
Light Manufacturing	-	-	-	-	-	8	11	-
Low-Density Residential	-	-	-	139	<1	-	-	-
Medium-Density Residential	-	-	-	45	6	-	-	-
Medium-High Density Residential	-	-	-	38	4	-	-	-
Municipality/Non-Municipal Urban Growth Area	-	1	3	54	22	10	2	-
Oak Harbor Mixed Use	-	-	36	38	329	188	15	-
Open Space	-	3	15	429	421	25	18	-
Parks and Recreation	-	1	3	658	203	219	29	-
Planned Business Park	-	-	-	17	58	-	-	-
Planned Industrial Park	-	-	-	6	141	40	-	-
Public Facilities	-	-	-	8	32	33	-	-
Rural	9	272	852	1,580	1,455	2,248	2,115	320
Rural Agriculture	3	149	121	144	77	226	142	144
Rural Forest	-	-	38	122	123	68	99	15
Rural Residential	-	-	44	78	33	90	19	-
Rural Service	-	1	-	-	-	4	1	-
Rural Village	-	-	-	-	-	26	-	-
Transportation, Communication, and Utilities	-	-	-	3	17	-	-	-
Water	-	-	118	-	31	45	117	21
Total	**14**	**437**	**1,497**	**4,014**	**3,181**	**3,468**	**2,597**	**510**

Sources: City of Oak Harbor 2019; Island County 2016[b]; Washington State 2018.
Notes:
Numbers have been rounded.
The "Federal" land use designation does not include the land within the boundaries of NASWI.
Total acreage presented may differ from the off-station acreages presented in Tables 4-1 and 5-1 due to slight differences in the Geographic Information System (GIS) layers for land area and the land use designations coverage.

OLF Coupeville

Existing land uses in the AICUZ footprint for OLF Coupeville, similar to those surrounding Ault Field, are primarily rural. Existing land uses are shown in Table 7-2 and Figure 7-4. Approximately 10,336 acres (87 percent of the land off-base that is within the AICUZ footprint) consist of Rural, Rural Agricultural, Rural Forest, Rural Reserve, Rural Residential, or Rural Service uses. Rural land uses surround the installation. Rural Residential areas are located to the south of the airfield near Admirals Cove, to the southwest off of W. Wanamaker Road, and along the shoreline south of Penn Cove. Large areas of Commercial Agricultural and Rural Agricultural uses are located west of the OLF. The Pacific Rim Institute for Environmental Stewardship is located northeast of the OLF on a large tract of land at the intersection of Route 20 and Parker Road. This property is developed with educational facilities and staff residences and also includes large areas of open space.

Various land uses are located north and northwest of the OLF outside of the town of Coupeville, including an Island Transit facility (indicated as light manufacturing), an animal shelter, transient lodging, and recreational facilities. In the town of Coupeville, areas included in the greater than 65-dB DNL noise contours for OLF Coupeville primarily are developed with Low-Density and Medium-Density Residential Uses, and Parks and Recreation uses. Several schools are located in Coupeville, and Coupeville High School, in the southern part of town, is located within the greater than 65-dB DNL noise contours.

TABLE 7-2 EXISTING LAND USES WITHIN THE AICUZ FOOTPRINT, OLF COUPEVILLE (ACRES)

LAND USE	ACCIDENT POTENTIAL ZONES[1]			NOISE LEVELS				
				NOISE ZONE 2		NOISE ZONE 3		
	CLEAR ZONE	APZ I	APZ II	65 TO 69 dB DNL	70 TO 74 dB DNL	75 TO 79 dB DNL	80 TO 84 dB DNL	85 TO 89 dB DNL
Commercial Agriculture	-	-	326	261	135	87	384	-
Federal	2	2	-	-	-	1	3	3
High-Density Residential	-	-	-	7	-	-	-	-
Light Manufacturing	-	1	-	-	-	2	11	15
Low-Density Residential	-	-	-	38	-	-	-	-
Medium-Density Residential	-	-	-	26	-	-	-	-
Municipality/Non-Municipal Urban Growth Area	-	-	-	9	<1	-	-	-
Parks and Recreation	-	-	-	66	3	-	-	-
Public/Quasi Public	-	-	-	9	-	-	-	-
Rural	52	284	626	684	694	2,704	1,681	71
Rural Agriculture	-	8	235	75	175	486	294	-
Rural Forest	3	90	-	303	110	434	295	20
Rural Reserve	-	-	-	81	4	-	-	-
Rural Residential	-	183	2	<1	28	478	149	85
Rural Service	-	-	-	1	-	-	-	-

TABLE 7-2 EXISTING LAND USES WITHIN THE AICUZ FOOTPRINT, OLF COUPEVILLE (ACRES)

LAND USE	ACCIDENT POTENTIAL ZONES[1]			NOISE LEVELS				
				NOISE ZONE 2		NOISE ZONE 3		
	CLEAR ZONE	APZ I	APZ II	65 TO 69 dB DNL	70 TO 74 dB DNL	75 TO 79 dB DNL	80 TO 84 dB DNL	85 TO 89 dB DNL
Special Review District	-	-	-	-	-	177	-	-
Town Commercial	-	-	-	<1	-	-	-	-
Water	-	-	-	-	-	29	-	-
Total	**57**	**568**	**1,189**	**1,561**	**1,149**	**4,398**	**2,817**	**194**

Sources:
Town of Coupeville 2009
Island County 2016[b]

Notes:
Numbers have been rounded.
The "Federal" land use designation does not include the land within the boundaries of OLF Coupeville.
Total acreage presented may differ from the off-station acreages presented in Tables 4-2 and 5-2 due to slight differences in the Geographic Information System (GIS) layers for land area and the land use designations coverage.

7.2.2 Zoning Surrounding NASWI

Zoning is a system of land use regulations that controls the physical development of land.

"Zoning" is a term used in urban planning for a system of land use regulations. Zoning is the system local governments use to control the physical development and use of the land. The zoning ordinance is the principal tool for implementing a comprehensive plan. While the comprehensive plan provides broad policy direction on land use, the zoning ordinance provides the specific rules under which land can be developed and used. This includes standards for building setbacks, height restrictions, lot coverage, and design requirements. Zoning ordinances provide the regulatory framework to direct development and influence how the various uses interact with each other to prevent conflicts and incompatibility. The lands surrounding Ault Field and OLF Coupeville have zoning classifications that mostly reflect existing land uses. Establishing and/or enforcing zoning ordinances is the desired method to address AICUZ guidelines and promote compatible land use around the airfields.

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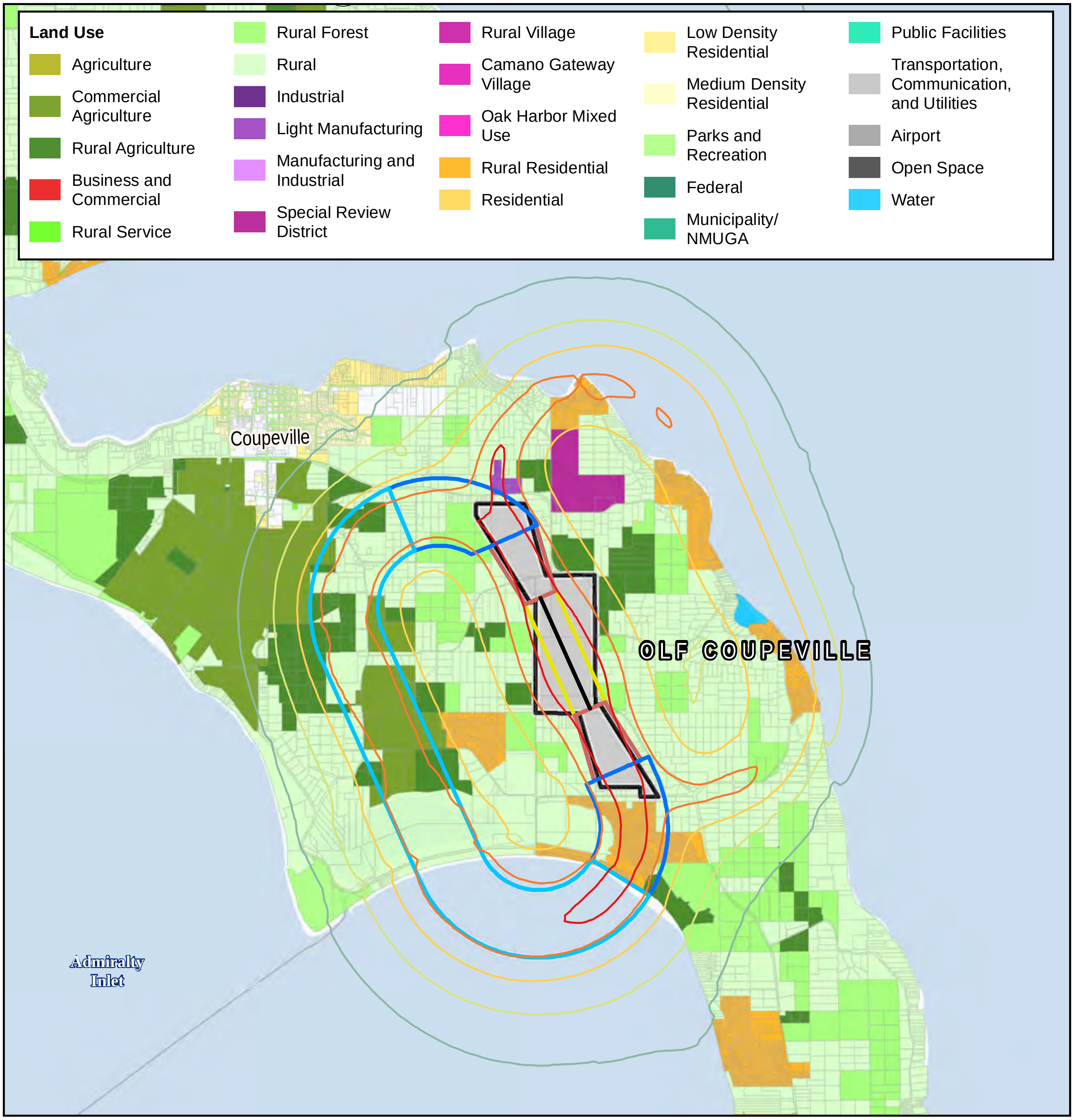

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Legend

Highway	Noise Contour	Accident Potential Zones (APZs)
Runway	65 dB DNL	Primary Surface
Installation Area	70 dB DNL	Clear Zone
Parcel Boundary	75 dB DNL	APZ I
	80 dB DNL	APZ II
	85 dB DNL	

Figure 7-4
2021 AICUZ Footprint with Existing Land Use, OLF Coupeville
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2020c; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

AULT FIELD

Zoning districts within the AICUZ footprint for Ault Field are shown in Table 7-3 and on Figure 7-5. Zoning districts in Island and Skagit counties and the city of Oak Harbor within the AICUZ footprint include Rural, Agricultural, Open Space, Residential, Commercial, Industrial and Manufacturing, and Mixed-Use and Planned Development districts. Similar to conditions for existing land uses, the Rural districts are the predominant zoning districts around Ault Field. Residential, Commercial, and Mixed-Use and Planned Development districts primarily are located in the city of Oak Harbor south of the base.

Various non-residential zoning districts in Island and Skagit counties and the city of Oak Harbor allow residential uses that may be incompatible. In unincorporated Island County, non-residential districts that allow single-family residences include the Rural, Rural Agriculture, Commercial Agriculture, and Rural Forest zoning districts. In Skagit County, agriculture zoning districts (including the Agriculture – Natural Resource Lands and Rural Reserve – Natural Resource Lands districts, which are shown in Table 7-3 and on Figure 7-5 as the "Agriculture" district) allow single-family residences. In Oak Harbor, non-residential districts including the Community Commercial district and Open Space, Recreation, and Agriculture district (shown in Table 7-3 and on Figure 7-5 as the "Open Space" district) allow single-family residences. The Oak Harbor Mixed-Use generalized zoning category also includes residential uses.

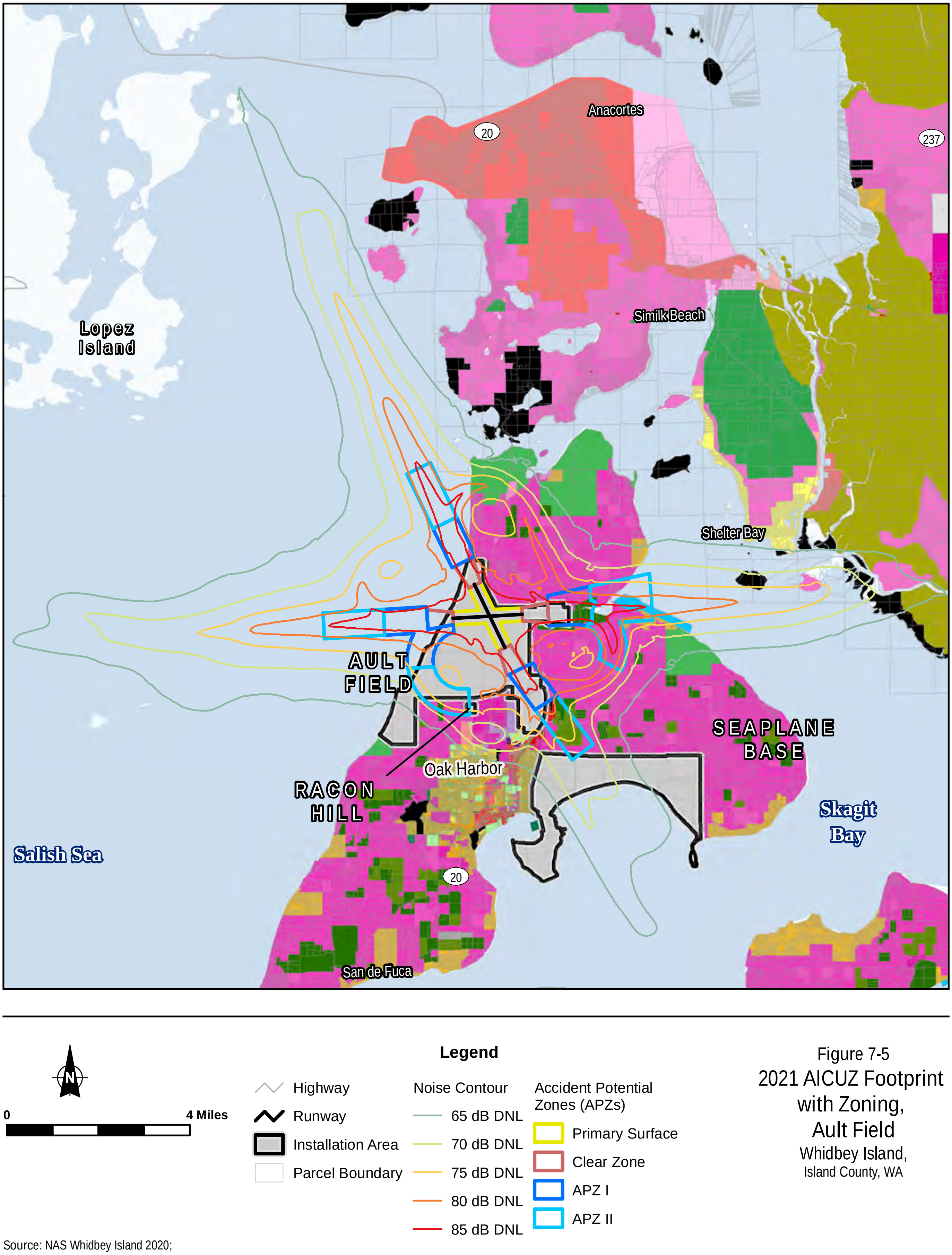

Figure 7-5
2021 AICUZ Footprint with Zoning, Ault Field
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Ecology and Environment 2020; Island County 2019. Skagit County 2019,

Zoning District

- Agriculture
- Commercial Agriculture
- Rural Agriculture
- Auto/Industrial Commercial
- Business
- Business and Commercial
- Central Business District
- Community Commercial
- General Commercial
- Historic/Limited Commercial
- Highway Corridor Commercial
- Incorporated Area
- Neighborhood Commercial
- Planned Business Park
- Rural Buisness
- Swinomish Commercial
- Town Commercial
- Industrial
- Light Manufacturing
- Manufacturing and Industrial
- Planned Industrial Park
- Rural Marine Industrial
- Bayview Ridge Mixed Use
- Camano Gateway Village
- Oak Harbor Mixed Use
- Residential Office
- Rural
- Rural Center
- Rural Forest
- Rural Intermediate
- Rural Reserve
- Rural Service
- Rural Village
- Special Review District
- Urban Development District
- Urban Growth Area
- High Density Residential
- Low Density Residential
- Rural Residential
- Medium-High Density Residential
- Medium Density Residential
- Residential
- Swinomish Residential
- Federal
- Municipality/NMUGA
- Memorandum of Agreement
- Natural Resource
- Parks
- Parks and Recreation
- Planned Unit Development
- Public Facilities
- Public/Quasi Public
- Aviation Related
- Airport
- Maritime
- Transportation, Communication, and Utilities
- Open Space
- Water

Table 7-3 provides the total composition of all the zoning districts within the Ault Field AICUZ footprint. An evaluation of land use compatibility is provided in Section 7.2.4, Compatibility Concerns.

TABLE 7-3 ZONING WITHIN THE AICUZ FOOTPRINT, AULT FIELD (ACRES)

	ACCIDENT POTENTIAL ZONES[1]			NOISE LEVELS				
				NOISE ZONE 2		NOISE ZONE 3		
ZONING DISTRICT	CLEAR ZONE	APZ I	APZ II	65 TO 69 dB DNL	70 TO 74 dB DNL	75 TO 79 dB DNL	80 TO 84 dB DNL	85 TO 89 dB DNL
Industrial	-	-	-	-	16	4	-	-
Agricultural	-	-	-	300	-	-	-	-
Open Space	-	3	15	292	176	10	18	-
Rural Reserve	-	-	-	261	37	42	-	-
Swinomish Residential	-	-	-	8	-	-	-	-
Commercial Agriculture	-	-	219	48	102	147	-	-
Federal	2	10	5	9	4	9	10	10
Light Manufacturing	-	-	-	-	-	8	11	-
Municipality/Non-Municipal Urban Growth Area	-	1	3	54	22	10	2	-
Rural	9	272	852	1,580	1,455	2,248	2,115	320
Rural Agriculture	3	149	121	144	77	226	142	144
Rural Forest	-	-	38	122	123	68	99	15
Rural Residential	-	-	44	78	33	90	19	-
Rural Service	-	1	-	-	-	4	1	-
Rural Village	-	-	-	-	17	26	-	-
Oak Harbor Mixed Use	-	-	36	38	329	188	15	-
Parks	-	1	3	632	203	219	29	-
Low-Density Residential	-	-	-	87	1	-	-	-
Medium-Density Residential	-	-	-	45	6	-	-	-
Planned Industrial Park	-	-	-	6	141	40	-	-
High-Density Residential	-	-	-	6	1	-	-	-
Public Facilities	-	-	-	8	32	33	-	-
Community Commercial	-	-	-	27	25	-	-	-
Auto/Industrial Commercial	-	-	43	<1	29	39	19	-

TABLE 7-3 ZONING WITHIN THE AICUZ FOOTPRINT, AULT FIELD (ACRES)

ZONING DISTRICT	ACCIDENT POTENTIAL ZONES[1]			NOISE LEVELS				
				NOISE ZONE 2		NOISE ZONE 3		
	CLEAR ZONE	APZ I	APZ II	65 TO 69 dB DNL	70 TO 74 dB DNL	75 TO 79 dB DNL	80 TO 84 dB DNL	85 TO 89 dB DNL
Highway Corridor Commercial	-	-	-	11	10	-	-	-
Medium-High Density Residential	-	-	-	38	4	-	-	-
Planned Business Park	-	-	-	17	58	-	-	-
Water	-	-	118	-	31	45	117	21
Total	**14**	**437**	**1,497**	**3,811**	**2,932**	**3,456**	**2,597**	**510**

Sources:
City of Oak Harbor 2019
Island County 2020[b]

Notes:
Numbers have been rounded.
The "Federal" zoning district does not include the land within the boundaries of NASWI.
Total acreage presented may differ from the off-station acreages presented in Tables 4-1 and 5-1 due to slight differences in the Geographic Information System (GIS) layers for land area and the zoning district coverage.

OLF COUPEVILLE

Zoning districts within the AICUZ footprint for OLF Coupeville are shown in Table 7-4 and on Figure 7-6. Zoning districts in unincorporated Island County and the town of Coupeville within the AICUZ footprint include Rural, Residential, Commercial, Light Manufacturing, Parks, and Public/Quasi Public. Rural zoning districts in unincorporated parts of the county are the predominant zoning type around the airfield. Residential and Public/Quasi-Public zoning districts are located within the town of Coupeville.

An Island County special review district is located northeast of the OLF at the intersection of Route 20 and Parker Road. This area is currently developed with rural land uses. According to the County's zoning ordinance, future development in this district will require completion of a master plan and must be completed in accordance with special standards that have been established to protect historical, archaeological, and/or environmental features of significance (Island County Code of Ordinances Section 17.03.160).

Table 7-4 provides the total composition of all zoning districts within the OLF Coupeville AICUZ footprint. An evaluation of land use compatibility is provided in Section 7.2.4, Compatibility Concerns. As noted above, Island County non-residential zoning districts, including the Rural, Rural Agriculture, Commercial Agriculture, and Rural Forest zoning districts, allow single-family residential uses that would be a consideration for land use compatibility planning.

TABLE 7-4 ZONING WITHIN THE AICUZ FOOTPRINT, OLF COUPEVILLE (ACRES)

ZONING DISTRICT	ACCIDENT POTENTIAL ZONES[1]			NOISE LEVELS				
				NOISE ZONE 2		NOISE ZONE 3		
	CLEAR ZONE	APZ I	APZ II	65 TO 69 dB DNL	70 TO 74 dB DNL	75 TO 79 dB DNL	80 TO 84 dB DNL	85 TO 89 dB DNL
Rural Reserve	-	-	-	81	4	-	-	-
Commercial Agriculture	-	-	326	261	135	87	384	-
Federal	2	2	-			1	3	3
Light Manufacturing	-	1	-			2	11	15
Municipality/Municipality/Non-Municipal Urban Growth Area	-	-	-	9	<1	-	-	-
Rural	52	284	626	684	694	2,704	1,681	71
Rural Agriculture	-	8	235	75	175	486	294	-
Rural Forest	3	90	-	303	110	434	295	20
Rural Residential	-	183	2	<1	28	478	149	85
Rural Service	-	-	-	1	-	-	-	-
Parks	-	-	-	66	3	-	-	-
Low Density Residential	-	-	-	38	-	-	-	-
Medium Density Residential	-	-	-	26	-	-	-	-
High Density Residential	-	-	-	7	-	-	-	-
Special Review District	-	-	-			177	-	-
Town Commercial	-	-	-	<1	-	-	-	-
Public/Quasi Public	-	-	-	9	-	-	-	-
Water	-	-	-	-	-	29	-	-
Total	**57**	**568**	**1,189**	**1,561**	**1,150**	**4,398**	**2,817**	**194**

Sources:
Town of Coupeville 2009
Island County 2020[b]

Notes:
Numbers have been rounded.
The "Federal" zoning district does not include the land within the boundaries of OLF Coupeville.
Total acreage presented may differ from the off-station acreages presented in Tables 4-2 and 5-2 due to slight differences in the Geographic Information System (GIS) layers for land area and the zoning district coverage.

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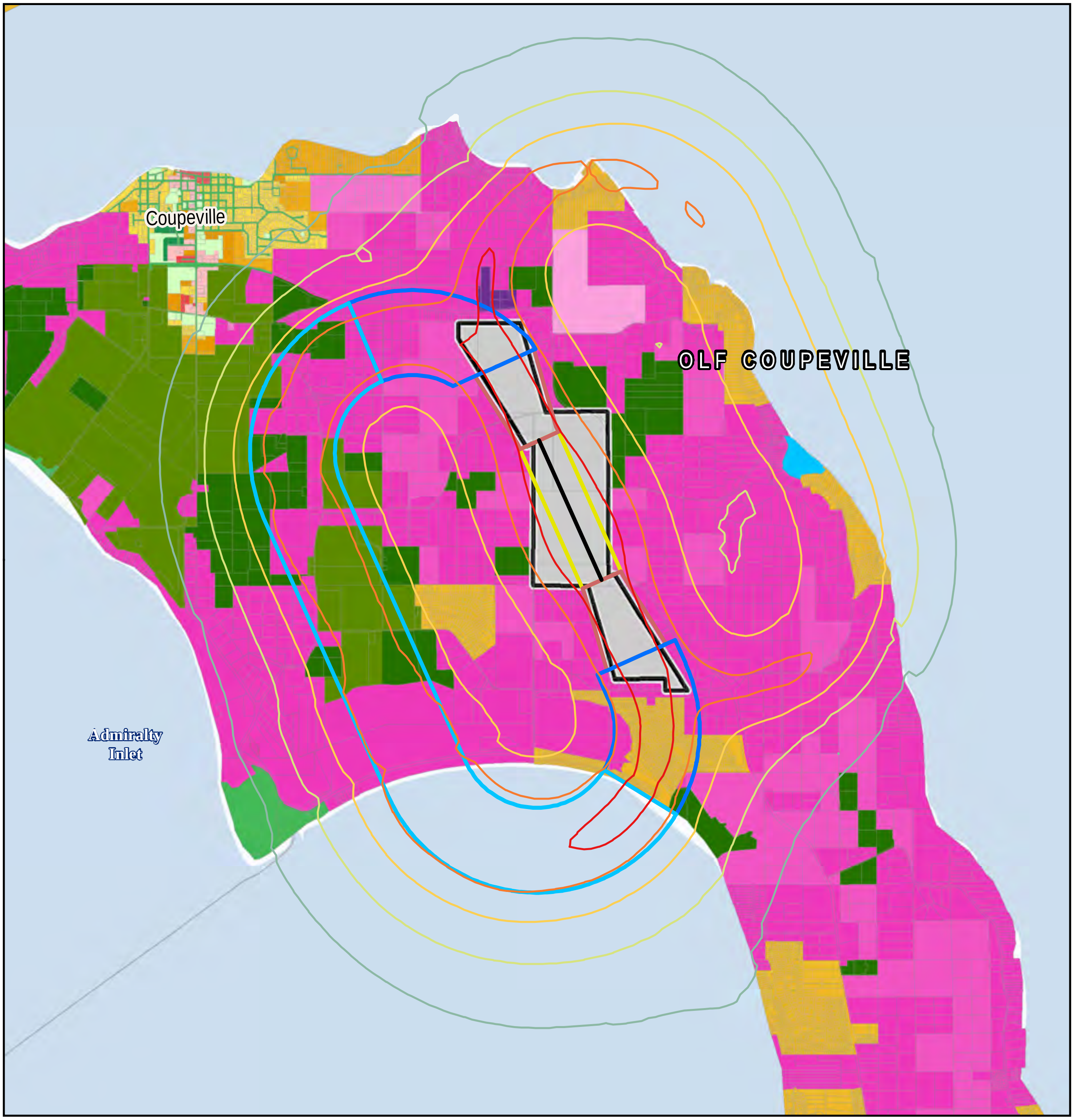

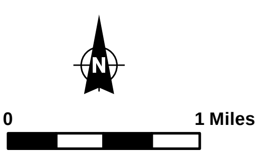

Legend

Highway	Noise Contour	Accident Potential Zones (APZs)
Runway	65 dB DNL	Primary Surface
Installation Area	70 dB DNL	Clear Zone
Parcel Boundary	75 dB DNL	APZ I
	80 dB DNL	APZ II
	85 dB DNL	

Figure 7-6
2021 AICUZ Footprint with Zoning, OLF Coupeville
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Ecology and Environment 2020; Island County 2019. Skagit County 2019,


Zoning District
Agriculture
Commercial Agriculture
Rural Agriculture
Auto/Industrial Commercial
Business
Business and Commercial
Central Business District
Community Commercial
General Commercial
Historic/Limited Commercial
Highway Corridor Commercial
Incorporated Area
Neighborhood Commercial
Planned Business Park
Rural Buisness
Swinomish Commercial
Town Commercial
Industrial
Light Manufacturing
Manufacturing and Industrial
Planned Industrial Park
Rural Marine Industrial
Bayview Ridge Mixed Use
Camano Gateway Village
Oak Harbor Mixed Use
Residential Office
Rural
Rural Center
Rural Forest
Rural Intermediate
Rural Reserve
Rural Service
Rural Village
Special Review District
Urban Development District
Urban Growth Area
High Density Residential
Low Density Residential
Rural Residential
Medium-High Density Residential
Medium Density Residential
Residential
Swinomish Residential
Federal
Municipality/NMUGA
Memorandum of Agreement
Natural Resource
Parks
Parks and Recreation
Planned Unit Development
Public Facilities
Public/Quasi Public
Aviation Related
Airport
Maritime
Transportation, Communication, and Utilities
Open Space
Water

7.2.3 Future Land Use Surrounding NASWI

The GMA (RCW 36.70A.110) requires counties and incorporated municipalities to identify UGAs, areas where the majority of future urban growth will be directed. UGAs and other designated areas targeted for future growth in the vicinity of NASWI were evaluated using data from Island County, City of Oak Harbor, Town of Coupeville, Skagit County, and San Juan County. The analysis identifies designated growth areas within the 2021 AICUZ footprint and, where possible, based on locally available data and projected land uses within these areas.

Ault Field

Designated areas targeted for future growth within the AICUZ footprint for Ault Field are shown in Table 7-6 and Figure 7-7. Island County has established future land use designations and identified UGAs, JPAs, and RAIDs as areas where most future growth will be directed. See Section 6.1.4, Island County, for definitions of each of these areas. As shown in the table and on the figure, parts of Oak Harbor's UGA and JPA are within the 2021 AICUZ footprint for Ault Field. These include unincorporated areas of the UGA south of Ault Field including areas east and west of North Oak Harbor Street and along Northeast Regatta Drive, as well as unincorporated areas of the JPA south and southeast of the airfield outside of the developed urban areas of Oak Harbor.

Approximately 624 acres of the unincorporated UGA experience noise exposure greater than 65 dB DNL and 35 acres are within the APZs. Mixed uses are planned for the areas of the UGA within the 2021 AICUZ footprint, including industrial/business park, high-intensity commercial, public facilities, low-density residential, and open space (City of Oak Harbor 2016).

Approximately 1,391 acres of the City of Oak Harbor's JPA experience noise exposure greater than 65 dB DNL and 556 acres are within the APZs. The City does not designate existing or future land uses in the JPA. Island County has designated future land use for land within the JPA as rural lands.

Island County has established future land use designations for unincorporated areas of the county near Ault Field outside of the UGA and JPA for Oak Harbor. Most of the unincorporated areas of the county within the 2021 AICUZ footprint for Ault Field have a future land use designation of "rural lands." Planned land uses in these areas include rural, rural forest, rural agriculture, parks, and commercial agriculture (Island County 2016[a]). Two residential RAIDs are located within the AICUZ footprint for Ault Field, Dugualla Bay Heights, and Sunrise Hills. Both are located along the shoreline of Dugualla Bay. The Dugualla Bay Heights RAID is located within the 70-dB DNL noise contour, as well as partially within APZ II. The Sunrise Hills RAID is located within both the 65 to 69-dB and 70 to 74-dB DNL noise zones. Three non-residential RAIDs also are located within the 2021 AICUZ footprint for Ault Field:

- The Midget Market non-residential RAID is located east of Ault Field on Route 20. This RAID is within the 80 to 84-dB DNL noise zone and APZ I.
- The Soundview Shopper non-residential RAID is located north of Ault Field within the 75 to 79-dB DNL noise zone.

- The Deception Pass non-residential RAID, which includes an RV park and camping facilities, is located north of Ault Field within the 70 to 74-dB DNL noise zone.

According to the County's comprehensive plan, residential and non-residential RAIDs are established around existing areas of more intensive rural land uses and form boundaries within which more intensive residential and non-residential rural uses will be contained (Island County 2016[a]).

Skagit County has established UGAs for incorporated cities and towns. The UGA for La Conner is located north of the 2021 AICUZ footprint for Ault Field, but does not fall within the AICUZ footprint. Skagit County has not established future land use designations for unincorporated areas of the county.

The 2021 AICUZ footprint for Ault Field overlaps James Island Marine State Park and Bird Rocks in San Juan County. James Island Marine State Park is managed by Washington State Parks, and Bird Rocks are part of the San Juan Islands Wilderness, managed by the USFWS. These islands are and will continue to be managed for conservation and limited recreation.

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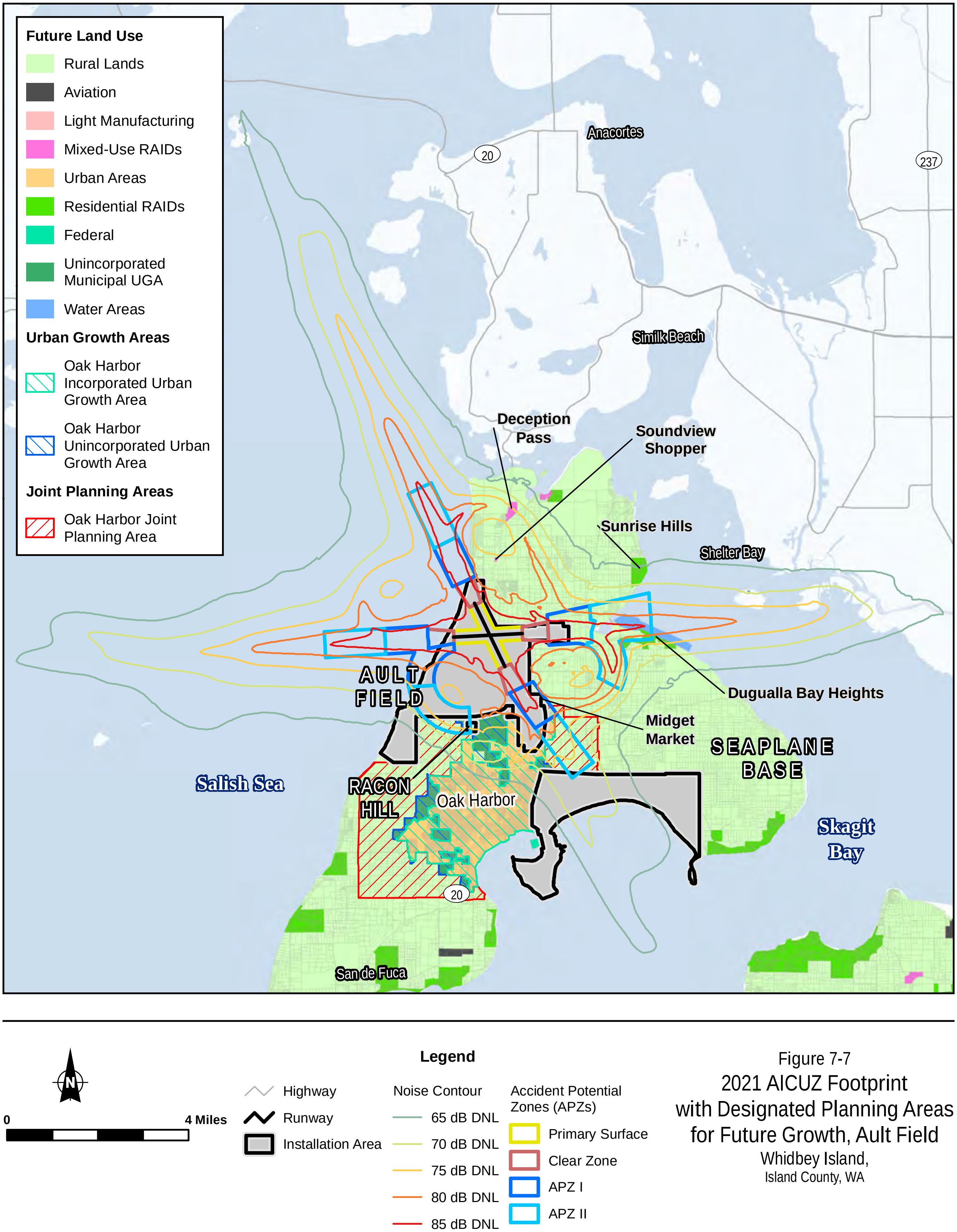

Figure 7-7
2021 AICUZ Footprint with Designated Planning Areas for Future Growth, Ault Field
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Ecology and Environment 2020; Washington State GIS 2018; Island County 2012.

TABLE 7-6 DESIGNATED AREAS TARGETED FOR FUTURE GROWTH WITHIN THE AICUZ FOOTPRINT, AULT FIELD (ACRES)

AREA	ACCIDENT POTENTIAL ZONES[1]			NOISE LEVELS				
				NOISE ZONE 2		NOISE ZONE 3		
	CLEAR ZONE	APZ I	APZ II	65 TO 69 dB DNL	70 TO 74 dB DNL	75 TO 79 dB DNL	80 TO 84 dB DNL	85 TO 89 dB DNL
Oak Harbor Unincorporated UGA	-	-	35	38	369	191	26	-
Oak Harbor JPA Area	-	32	524	267	698	375	51	-
Non-Residential RAIDs	-	1	-	-	17	30	1	-
Residential RAIDs	-	-	43	78	33	90	18	-
Rural Lands	12	421	1,231	2,472	1,938	2,896	2,383	478
Urban Areas	-	7	121	614	694	250	78	-
Federal	2	11	6	9	5	9	11	10
Light Manufacturing	-	-	-	-	-	7	11	-
Total	**14**	**472**	**1,960**	**3,478**	**3,754**	**3,848**	**2,579**	**488**

Sources:
Island County Geographic Information System (GIS) Department 2020[a], 2020[b], 2020[c], 2020[d]

Notes:
Numbers have been rounded.
Acreage within the Oak Harbor JPA is listed separately but is made up of acreage classified as "Rural Lands" or "Federal" by Island County.
The "Federal" area does not include the land within the boundaries of NASWI.

OLF Coupeville

Designated areas targeted for future growth within the AICUZ footprint for OLF Coupeville are shown in Table 7-7 and Figure 7-8. The Town of Coupeville has established future land use designations in its comprehensive plan. These designations are equivalent to the Town's zoning districts, which are discussed in Section 7.2.2, Zoning Surrounding NASWI, and shown in Table 7-4 and Figure 7-6.

The town's UGA follows the town boundary and does not include any unincorporated areas of Island County, as noted in Section 6.1.4, Island County. As shown in Table 7-7, approximately 174 acres of the UGA experience noise exposure greater than 65 dB DNL. These areas are developed or will be developed with low- and medium-density residential and public/quasi-public uses.

As noted in the discussion for Ault Field, most of the unincorporated areas of Island County within the 2021 AICUZ footprint for OLF Coupeville have a future land use designation of "rural lands". These areas are intended for rural, rural forest, rural agriculture, parks and commercial agriculture uses (Island County 2016[a]). Other types of future land use designations within the AICUZ footprint include a special review district for the Pacific Rim Institute for Environmental Stewardship, located northeast of the airfield, and an area designated for light manufacturing located north of the airfield. The County also has designated both of these areas as non-residential RAIDs. The Pacific Rim Institute is located almost entirely within the 70 to 74 dB DNL noise zone. The land designated for light manufacturing uses is within the 80 to 84 dB and greater than 85 dB DNL noise zones and is partially within APZ I.

Five residential RAIDs and one non-residential RAID are also located within the 2021 AICUZ footprint for OLF Coupeville. These areas are described below.

- The Crockett Lake residential RAID is located west of OLF Coupeville and includes the existing Crockett Lake neighborhood. The RAID is located mostly within the 70 to 74-dB DNL noise zone, though the westernmost boundary of the RAID and several existing homes are within the 75 to 79-dB DNL noise zone.
- The Admiral's Cove residential RAID is located southeast of the airfield and includes the existing Admiral's Cove neighborhood and Admiral's Cove Beach Club. The majority of this RAID is located in APZ I and has various portions within the 75 to 79-dB, 80 to 84-dB, and greater than 85-dB DNL noise zones.
- The Race Lagoon and Harrington Lagoon residential RAIDs are located east of the airfield along the eastern shoreline of Whidbey Island. Both RAIDs are within the 75 to 79-dB DNL noise zone.
- The Snakelum Point residential RAID is located northeast of the airfield and north of the Pacific Rim Institute. This RAID is primarily located in the 75 to 79-dB DNL noise zone, though parts of the RAID on the shoreline are within the 80 to 84-dB DNL noise zone.
- The Ebey's Bowl non-residential RAID, established around a bowling alley, is located northeast of the airfield on Southeast Terry Road. The RAID is within the 65 to 69-dB DNL noise zone.

TABLE 7-7 DESIGNATED AREAS TARGETED FOR FUTURE GROWTH WITHIN THE AICUZ FOOTPRINT, OLF COUPEVILLE (ACRES)

AREA	ACCIDENT POTENTIAL ZONES[1]			NOISE LEVELS				
				NOISE ZONE 2		NOISE ZONE 3		
	CLEAR ZONE	APZ I	APZ II	65 TO 69 dB DNL	70 TO 74 dB DNL	75 TO 79 dB DNL	80 TO 84 dB DNL	85 TO 89 dB DNL
Coupeville UGA	-	-	-	170	4	-	-	-
Non-Residential RAIDs	-	-	-	1	-	-	-	-
Residential RAIDs	-	183	2	<1	29	478	149	85
Rural Lands	54	383	1,188	1,380	1,118	3,712	2,653	91
Federal	2	2	-	-	-	1	4	3
Light Manufacturing	-	2	-	-	-	2	11	15
Special Review Districts	-	-	-	-	-	177	-	-
Total	**56**	**570**	**1,190**	**1,552**	**1,151**	**4,370**	**2,817**	**194**

Sources:
Island County Geographic Information System (GIS) Department 2020[a], 2020[c], 2020[d]

Notes:
Numbers have been rounded.
The "Federal" area does not include the land within the boundaries of NASWI.

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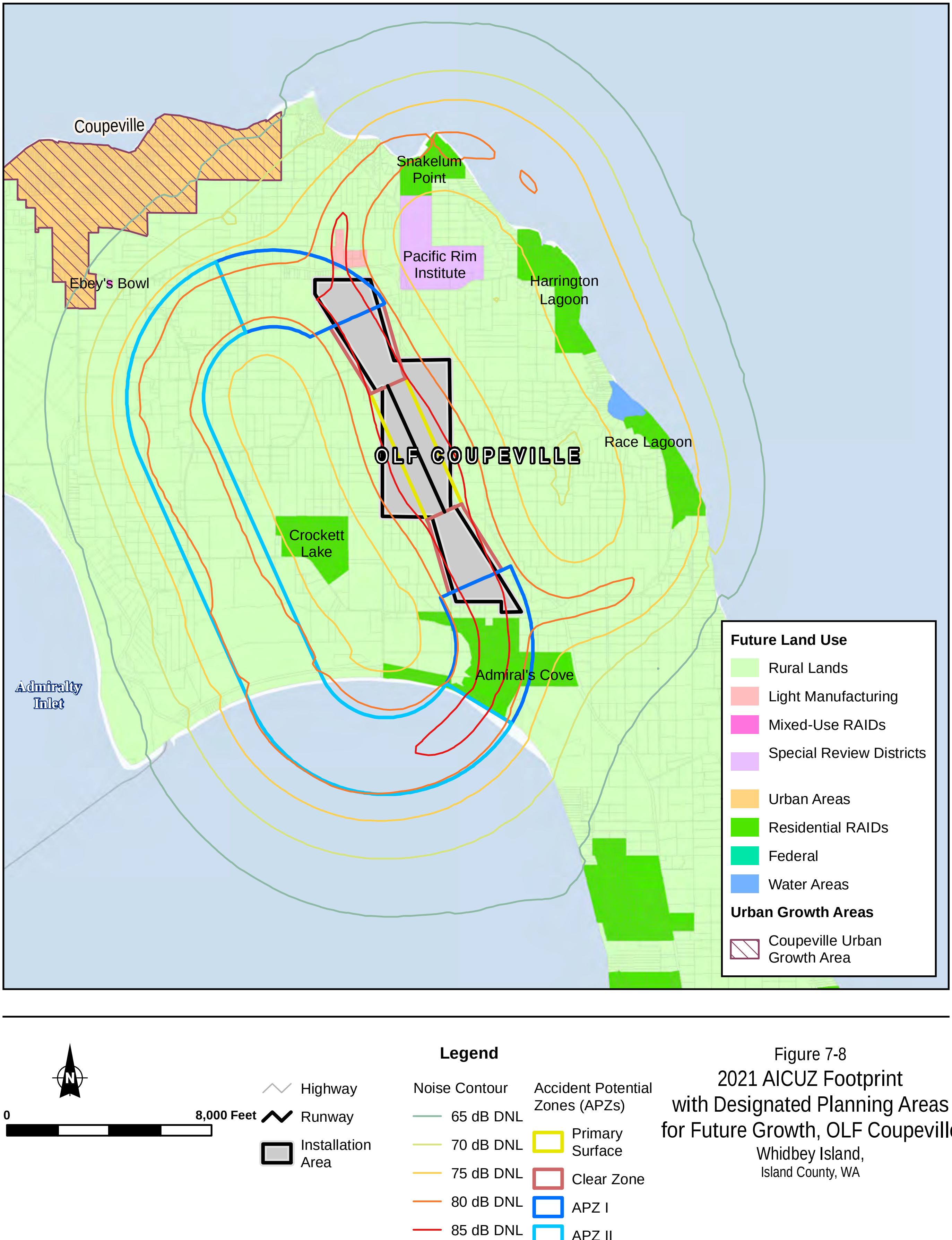

Figure 7-8
2021 AICUZ Footprint
with Designated Planning Areas
for Future Growth, OLF Coupeville
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020;
ESRI 2020, 2016; Ecology and Environment 2020;
Washington State GIS 2018; Island County 2012.

7.2.4 Compatibility Concerns

Overall, land use compatibility concerns are minimal to moderate due to the strong state and local land use controls intended to direct most development to existing urban areas, protect farmland and rural land uses, and prevent incompatible development (see Section 6.1, Planning Authorities, Policies, Regulations, and Programs). Identifying and minimizing potential incompatible land uses within the AICUZ footprint are objectives of this AICUZ Study. It is essential to NASWI's mission that incompatible land uses are identified and minimized, where possible, and that compatible land uses are promoted within the AICUZ footprint. In determining land use compatibility within the AICUZ footprint, the Navy examined existing land use patterns, zoning, and future land use designations near the airfield. Appendix B provides the Navy's complete land use compatibility classifications and the associated land use compatibility designations for noise zones and APZs from OPNAVINST 11010.36C.

Compatibility concerns in areas surrounding Ault Field and OLF Coupeville are discussed separately in the sections below and shown in the corresponding figures. General compatibility concerns related to existing and future land use and zoning designations are discussed, followed by discussion of specific areas of compatibility concern related to existing land use or potential future development. Recommendations are presented in Section 7.3, NASWI AICUZ Study Recommendations, and address specific land use compatibility issues identified.

To analyze whether existing and potential future land uses are compatible with aircraft operations, the 2021 AICUZ noise contours and APZs were overlaid on land use classification and future growth area data from Island, Skagit, and San Juan counties. Zoning compatibility was analyzed in a similar manner.

As previously stated, the AICUZ footprint for NASWI has increased in size overall when compared to the 2005 AICUZ footprint (see Sections 4.4.3, Comparison of Noise Contours, and 5.2.2, Comparison of 2005 and 2021 Clear Zones and APZs). Compared to the 2005 noise contours, the 2021 AICUZ noise contours are similar in shape, but cover a larger area. The 2021 AICUZ APZs have slightly decreased in area at Ault Field. However, at OLF Coupeville, operational changes have warranted the addition of APZs I and II at the airfield, which substantially changes the AICUZ footprint. These changes warrant detailed analysis of land use patterns surrounding NASWI and development of specific recommendations to ensure continued land use compatibility and effective coordination with local communities.

Figures 4-5, 4-6, 5-4, and 5-5 of this AICUZ Study compare 2005 and 2021 noise contours and APZs with the noise contours and APZs.

Ault Field Compatibility Concerns

Northern Whidbey Island, in the vicinity of Ault Field, is more densely developed than the area of Central Whidbey Island around OLF Coupeville. While most unincorporated areas of the county surrounding Ault Field are zoned for rural uses and designated as rural lands, the County's rural zoning districts permit the construction of potentially incompatible residential uses in noise zones and APZs. The majority of incompatible land uses within the AICUZ footprint in unincorporated Island County are residential uses. Specific areas of compatibility concern are discussed below and shown on Figure 7-9 and the accompanying figures with each section (Figures 7-10, 7-11, 7-12, 7-13, and 7-14).

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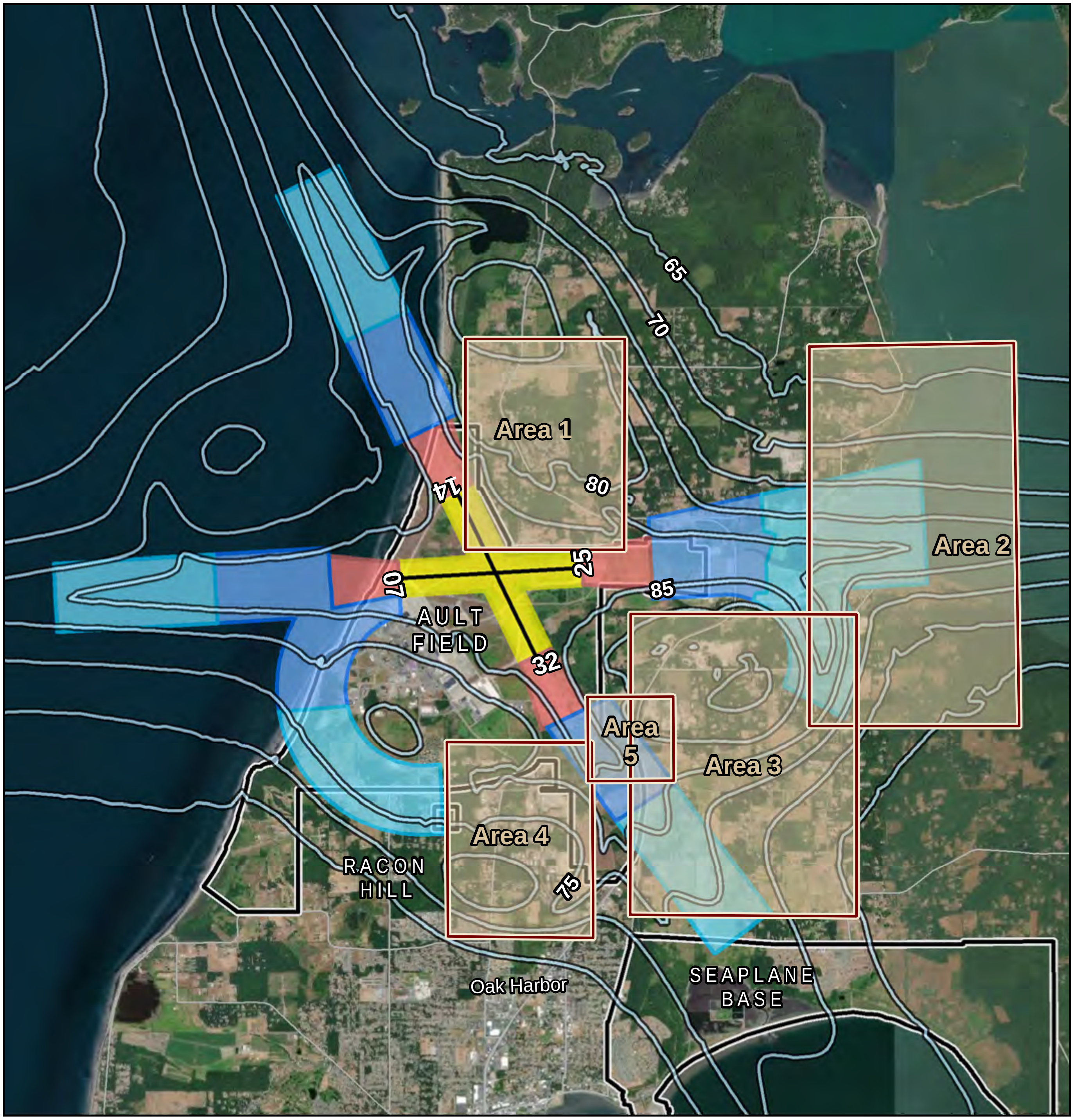
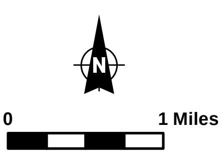




Legend

- Highway
- Noise Contour (dB DNL)
- Runway
- Installation Area
- Compatibilty Concern Areas

Accident Potential Zones (APZs)

- Primary Surface
- Clear Zone
- APZ I
- APZ II

Figure 7-9
Compatibility Concerns
Ault Field
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

Area 1: Residential Subdivision North of the Airfield

North of Ault Field, an existing residential subdivision at the intersection of Route 20 and West Banta Road is within the 75 to 79-dB DNL noise zone. As shown in Appendix B, residential uses are considered incompatible in this noise zone and should be discouraged (Figure 7-10). Future land use in this area is designated as "rural lands." The County has not established a residential RAID around this neighborhood; therefore, future residential development is not being encouraged. Additional residential development within this noise zone is not recommended.

Area 2: Dugualla Bay Heights and Sunrise Hills Residential RAIDs

Residential uses are considered compatible within APZ II; lower development densities of 1 to 2 dwelling units per acre (Du/Ac) are recommended in this area (Figure 7-11). The Dugualla Bay Heights residential RAID, consisting of existing medium-density residential development, on the southern shoreline of Dugualla Bay is within the 75 to 79-dB DNL and 80 to 84 dB-DNL noise zones and is considered incompatible. Portions of this residential neighborhood are also within APZ II.

The Sunrise Hills residential RAID on the northern shoreline of the bay has been established around existing medium-density residential development. This RAID is located partially within the 65 to 69-dB and 70 to 74-dB DNL noise zones. The Navy discourages single-family residential development in these noise zones and future residential development is not recommended.

Area 3: Mobile Home Parks Southeast of the Airfield

Multiple mobile home parks are located southeast of the airfield south of Pit Road and north of Fakkema Road. Future land use in this area is designated as "rural lands." Due to the concentration of people who reside at these locations, the mobile home parks are considered incompatible within the APZ (Figure 7-12). These mobile home parks experience noise exposure greater than 70 dB DNL and are considered incompatible due to the noise levels. Two mobile home parks closer to the airfield along Route 20 also are located within APZ I. All residential development is discouraged within this noise zone and all residential development is recommended incompatible within APZ I.

Area 4: Mixed Use Development in Oak Harbor and Unincorporated UGA

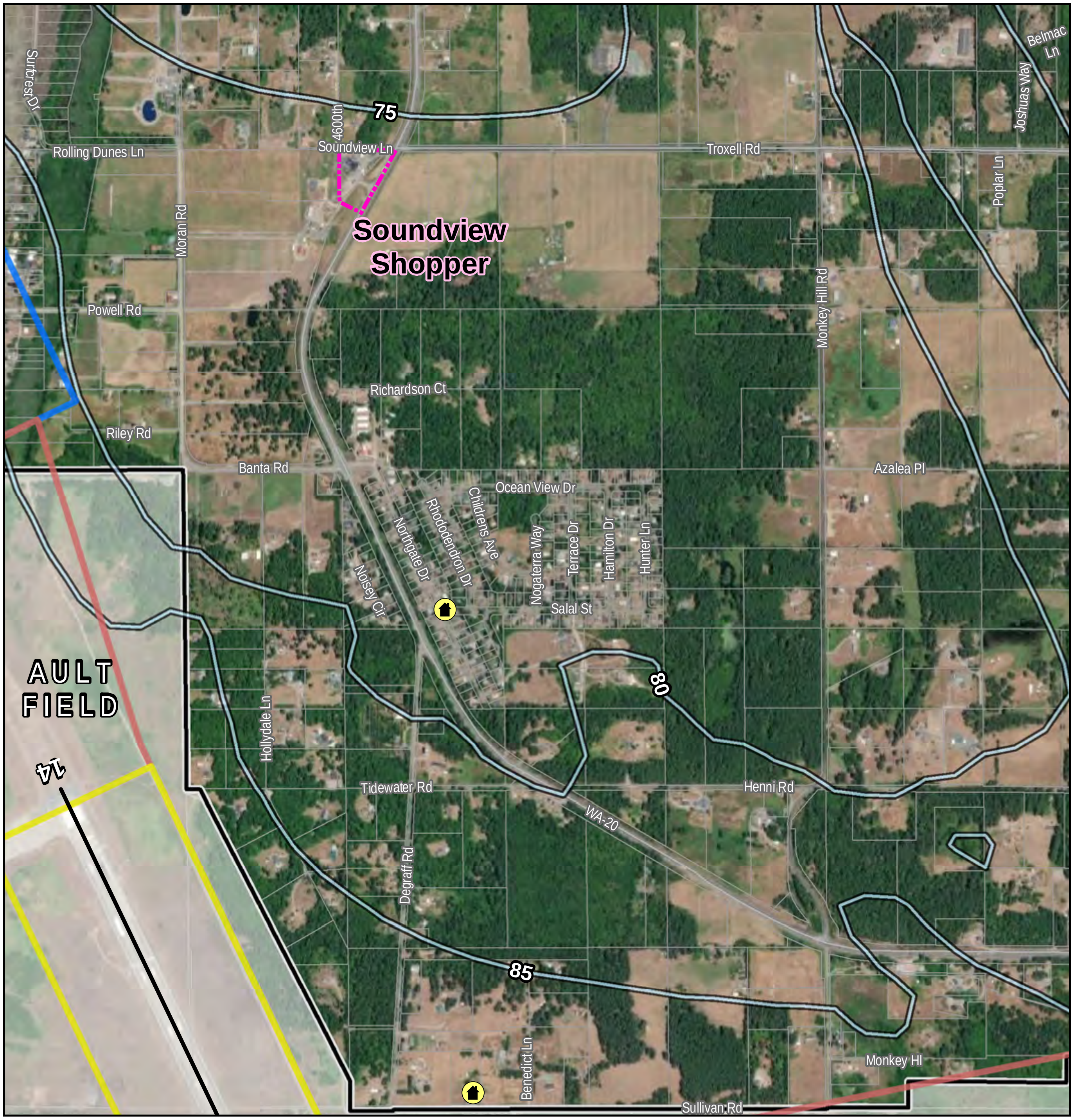
Land within Oak Harbor and the city's unincorporated UGA south of the airfield and north of Northeast 16th Avenue is zoned for industrial, business, and residential uses. This area experiences noise exposure greater than 65 dB DNL. Existing incompatible uses in this area include single-family residences and mobile home parks along North Oak Harbor Road.

In addition, businesses and a restaurant are located in the 75 to 79-dB DNL contour range. These existing uses may be incompatible (see Appendix B and Figure 7-13).

Future development planned for this area includes a mix of industrial/business park, high-intensity commercial, public facilities, low-density residential, and open space uses (City of Oak Harbor 2016). Additional residential development in this area is discouraged due to noise levels. Industrial/business park and commercial uses and public facilities would be considered compatible in most of this area with appropriate noise level reduction measures (see Appendix B). Commercial uses, professional services, and public facilities would be considered incompatible in the 80 to 84-dB DNL noise zone, which occurs in a small area of the UGA along Ault Field Road.

Area 5: Midget Market Non-Residential RAID

The Midget Market non-residential RAID is located east of Ault Field on Route 20 within the 80 to 84-dB DNL noise contour range, as well as APZ I (Figure 7-14). This type of commercial use is considered incompatible in these areas due to being in APZ I and noise exposure, and future incompatible commercial uses should be discouraged in this RAID, based on the recommendations in Appendix B.



N

0 1,000 Feet

Legend

- Residential
- Runway
- Noise Contour (dB DNL)
- Installation Area
- Non-Residential RAID

Accident Potential Zones (APZs)

- Primary Surface
- Clear Zone
- APZ I

Figure 7-10
Ault Field Area 1
Compatibility Concerns
Ault Field
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

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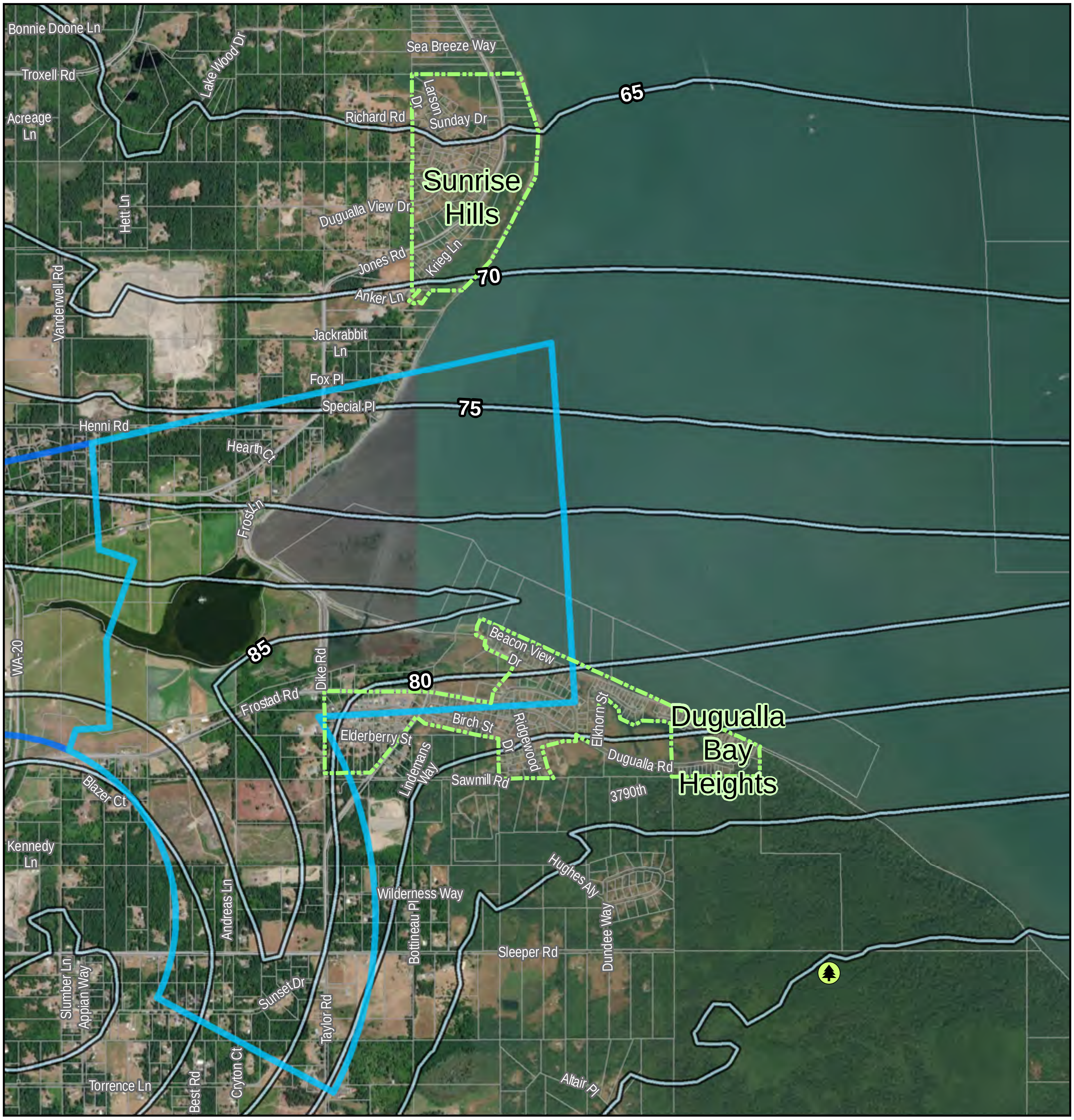

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Legend

- Park
- Runway
- Noise Contour (dB DNL)
- Residential RAID

Accident_Potential Zones (APZs)

- APZ I
- APZ II

Figure 7-11
Ault Field Area 2
Compatibility Concerns,
Ault Field
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

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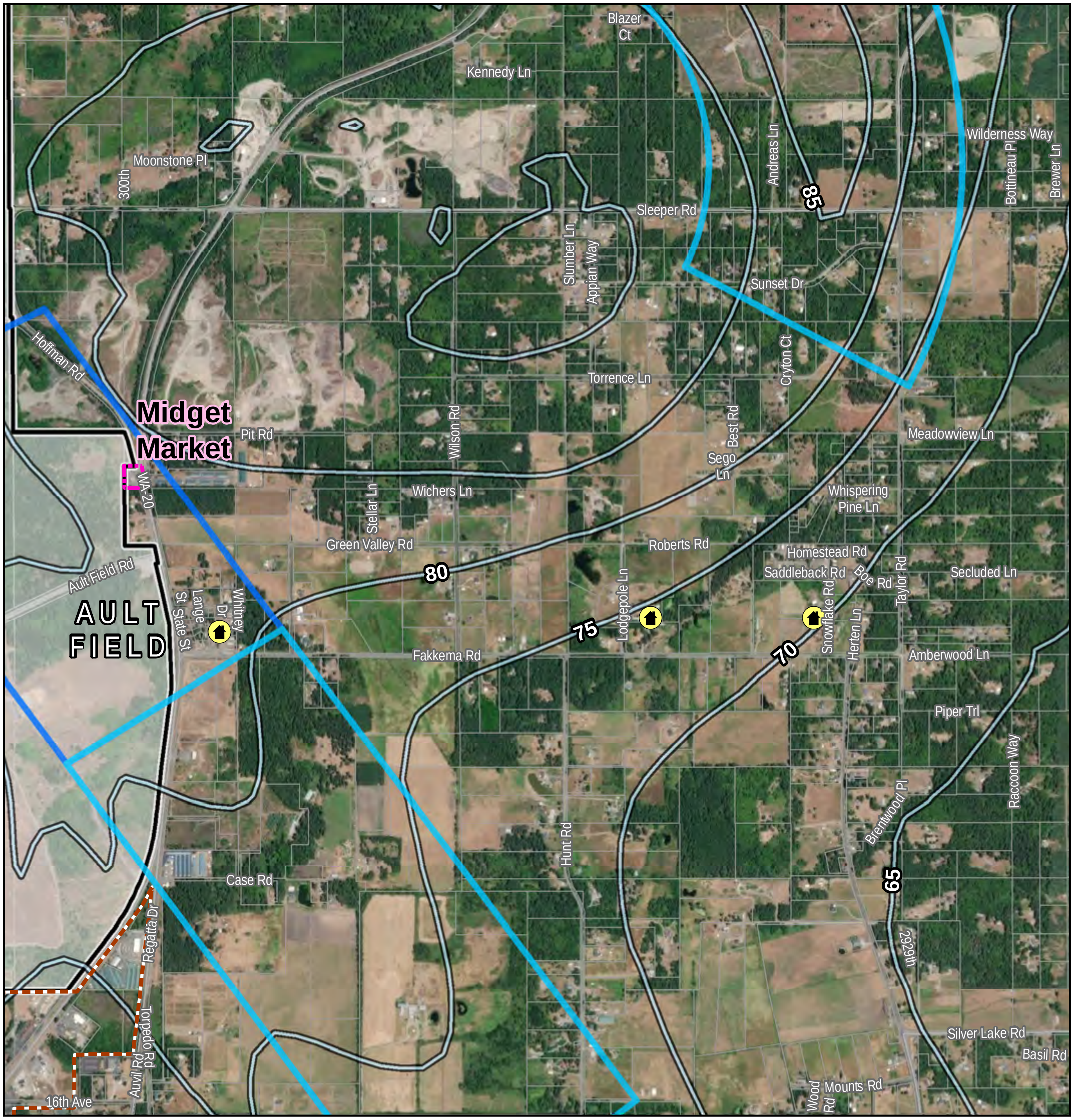

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Legend

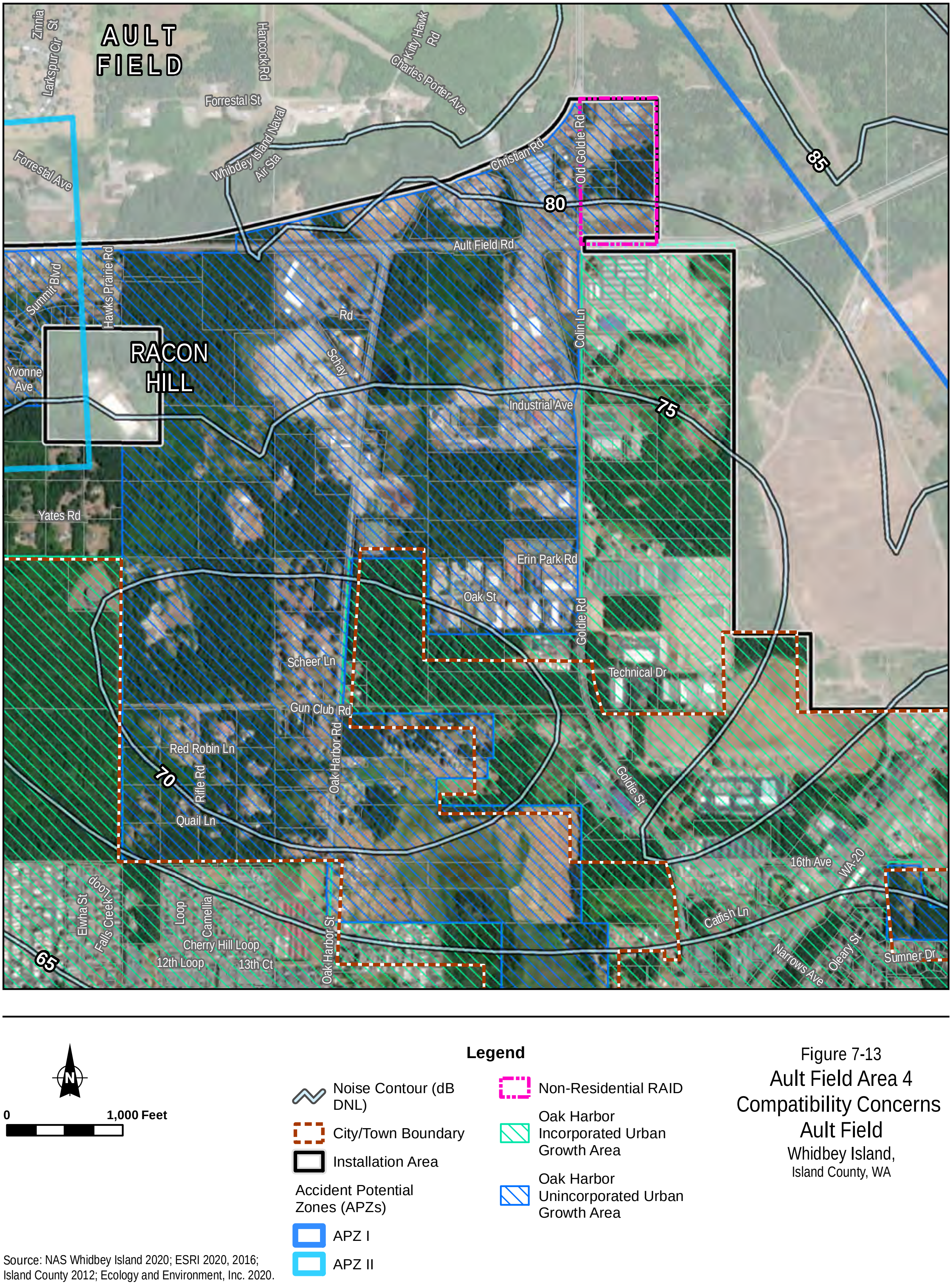
- Residential
- Noise Contour (dB DNL)
- City/Town Boundary
- Installation Area
- Non-Residential RAID

Accident Potential Zones (APZs)

- APZ I
- APZ II

Figure 7-12
Ault Field Area 3
Compatibility Concerns
Ault Field
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.



Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

Figure 7-13
Ault Field Area 4
Compatibility Concerns
Ault Field
Whidbey Island,
Island County, WA

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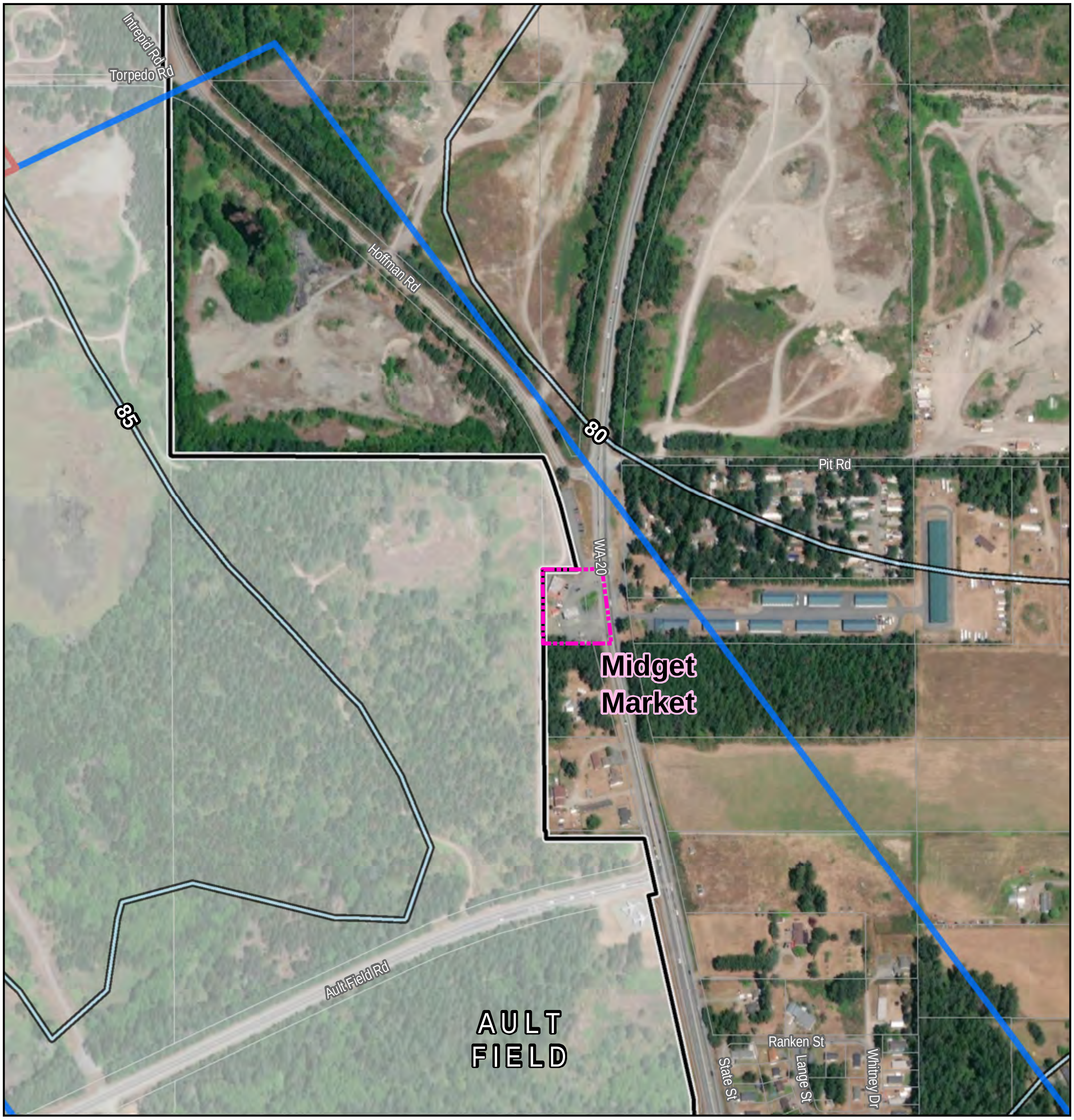

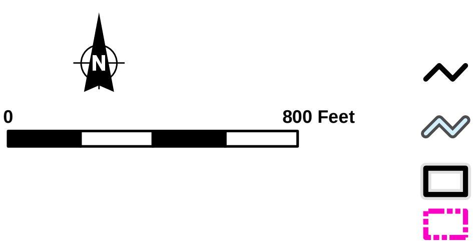

Figure 7-14
Ault Field Area 5
Compatibility Concerns
Ault Field
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

OLF Coupeville Compatibility Concerns

Noise contours and/or APZs extend off the airfield in all directions. The 2021 AICUZ noise contours that extend off the airfield range from the 65 dB DNL to the greater than 85-dB DNL noise contours, and these noise contours pose compatibility concerns with specific types of existing and future land uses and zoning, particularly residential uses. In addition, there are areas of compatibility concern within the APZs. Specific areas of compatibility concern are discussed in detail below and shown on Figure 7-15 and the figures accompanying each section (Figures 7-16, 7-17, 7-18, 7-19, and 7-20).

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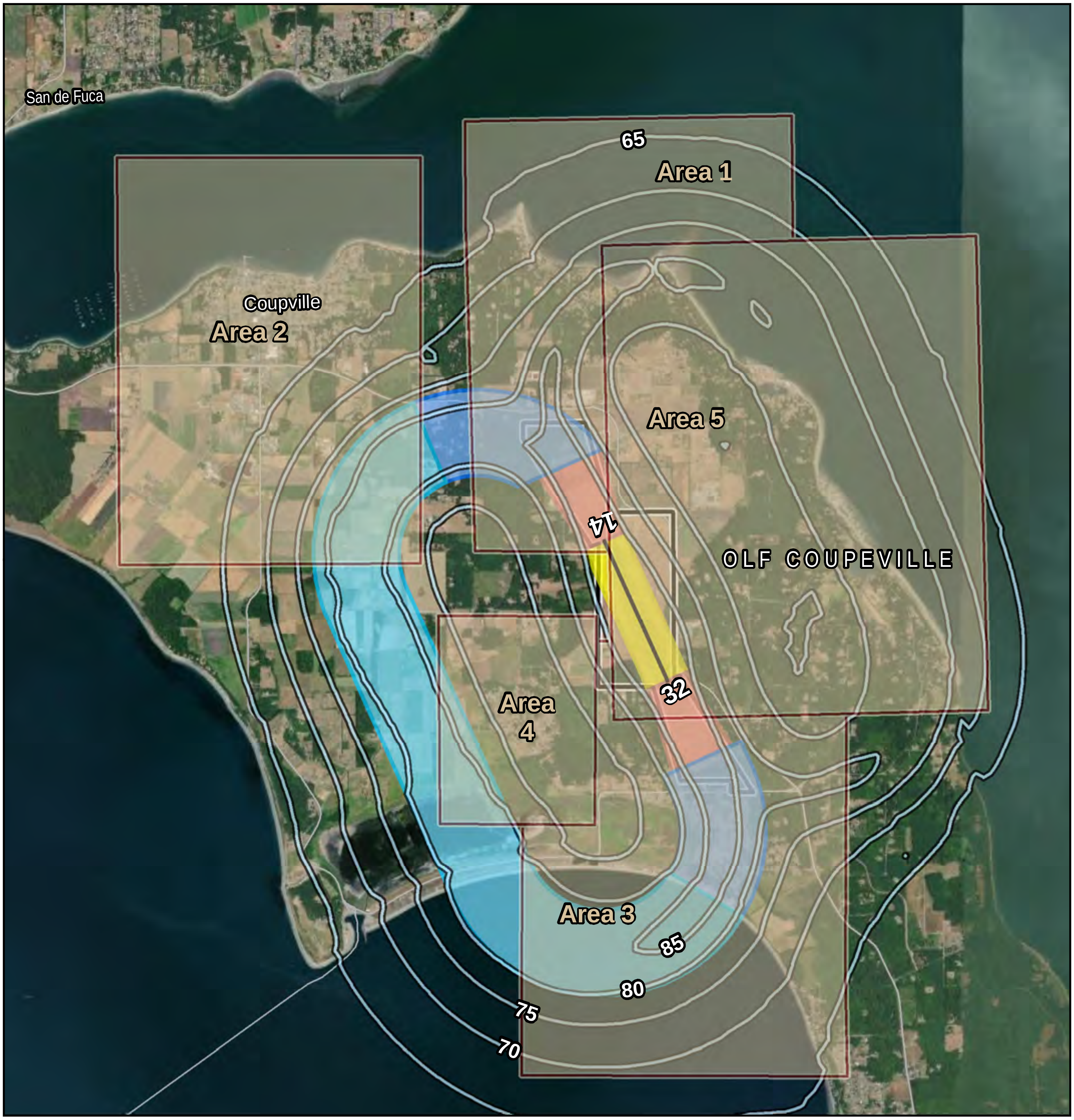

Figure 7-15
Compatibility Concerns, OLF Coupeville
Whidbey Island, Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

AREA 1: EXISTING AND FUTURE DEVELOPMENT ALONG ROUTE 20, NORTH OF AIRFIELD

Land along Route 20 north of the airfield is zoned for rural and light manufacturing uses and is developed with a mixture of land uses, including an animal shelter, transient lodging, a recreational association facility, a manufacturing facility, and an Island Transit facility. These existing uses wholly or partially experience noise exposure greater than 80 dB DNL, and some of these uses are located within APZ I. The AICUZ Instruction recommends that construction in the 80 to 84-dB DNL contour incorporate noise abatement techniques, and that activity within the 85 dB DNL and higher be restricted to uses such as agriculture and forestry, which are compatible. Existing manufacturing and residential development within this area is considered incompatible with Federal guidelines. Motor vehicle facilities, such as the Island Transit facility, are considered compatible in the 80 to 84-dB DNL noise contour range if noise level reduction measures are taken in areas where the public is received, offices, and other noise sensitive areas. Transient lodgings, facilities housing animals, and cultural activities, like recreational associations, are considered incompatible within the 80 to 84-dB DNL noise contour range. The manufacturing facility's noise exposure is greater than 85-dB DNL. Due to the noise levels in this contour range, no developed land uses are considered compatible.

Existing manufacturing uses in this area are located within a non-residential RAID. As noted above, no developed land uses are considered compatible in this noise contour range, and future development in this RAID is not recommended.

The transient lodging and recreation association facility are also located in APZ I. The AICUZ Program recommends that uses that concentrate groups of people, such as cultural activities and transient lodgings, are located outside of APZ I. Several single-family residences located off of Route 20 and Jacobs Road are within APZ I. These current and all future residential uses are not recommended compatible with APZ I.

The Pacific Rim Institute for Environmental Stewardship, designated by the County as a special review district for future development and a non-residential RAID, is located northeast of the airfield, almost entirely within the 70 to 75-dB DNL noise zone. The institute provides educational services, and existing land uses on the property include educational facilities and staff residences. AICUZ land use compatibility guidelines recommend measures to achieve an indoor noise level reduction of 30 dB for educational services facilities within this noise contour range, and residential land uses are considered incompatible and strongly discouraged in this noise contour range. Future expansion of residential facilities or the population housed on the institute's property would present a compatibility concern under the AICUZ Instruction for aircraft operations at OLF Coupeville (Figure 7-16).

AREA 2: TOWN OF COUPEVILLE, NORTHWEST OF AIRFIELD

The town of Coupeville is largely outside the area of noise impact from OLF Coupeville. However, southern portions of the town, including residential areas and Coupeville High School are located within the 65 to 69-dB DNL contour range. While residences are recommended incompatible in this noise contour range, many communities allow development in recognition of local need for housing. In these cases, it is recommended that noise level reduction measures are implemented to abate noise. Schools are considered compatible if noise level reduction measures are taken to reduce indoor noise levels by 25 dB (Figure 7-17).

Rural areas in the western part of the town south of Northeast Parker Road, which are zoned and have a future land use designation of "residential reserve," may be developed with low-density residential uses in the future. As noted above, single-family residential uses are considered incompatible in this contour range under the AICUZ Instruction.

Area 3: Admiral's Cove Residential RAID, South of Airfield

South of OLF Coupeville in the Admiral's Cove residential RAID, residences continue to experience noise exposure greater than 75 dB DNL. From 1986 to 2005, and again in 2021 moving forward, this development is also overlaid by APZ I. The Navy has consistently recommended against development of homes in this area, but local development pressures have resulted in a pattern of development not recommended by the AICUZ instruction.

A beach club is located on Keystone Avenue within APZ I and the 80 to 84-dB DNL noise contour range. While this type of use may be compatible in APZ I if it does not concentrate large numbers of people or children, outdoor recreational activities are considered incompatible in this noise contour range (Figure 7-18).

Area 4: Crockett Lake Residential RAID, West of Airfield

The Crockett Lake residential RAID, located west of OLF Coupeville off Wanamaker Road, is within the 70 to 74-dB DNL noise contour range. Residential uses are considered incompatible and are discouraged within this noise contour range. However, as noted above, if there is a demonstrated community need for housing within the 70 to 74-dB DNL contour range, the AICUZ Program recommends that measures to achieve an indoor noise level reduction of at least 30 dB be incorporated into building codes and in individual project approvals (see Appendix B).

APZ II lies to the west of this subdivision. While no existing residences of this subdivision are within the APZ at this location, expansion of this residential neighborhood to the west in the future may place homes within the APZ. While single-family residences are considered compatible within APZ II, AICUZ guidelines recommend residential development be low density (1 to 2 Du/Ac; Figure 7-19).

Area 5: Residential RAIDs, East and Northeast of Airfield

Three residential RAIDs, the Race Lagoon, Harrington Lagoon, and Snakelum Point RAIDs, are located along the shoreline east and northeast of OLF Coupeville (Figure 7-20). The Race Lagoon and Harrington Lagoon residential RAIDs are within the 75 to 79-dB DNL noise contour range. The Snakelum Point residential RAID is primarily located in the 75 to 79-dB DNL noise contour range, though parts of the RAID on the shoreline are within the 80 to 84-dB DNL noise contour range. Existing residential development in these RAIDs is considered incompatible due to noise levels.

0 2,000 Feet

Legend

- Park
- Residential
- Runway
- Noise Contour (dB DNL)
- City/Town Boundary
- Installation Area
- Residential RAID
- Non-Residential RAID
- Accident Potential Zones (APZs)
  - Primary Surface
  - Clear Zone
  - APZ I
  - APZ II

Figure 7-16
OLF Coupeville Area 1
Compatibility Concerns
OLF Coupeville
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

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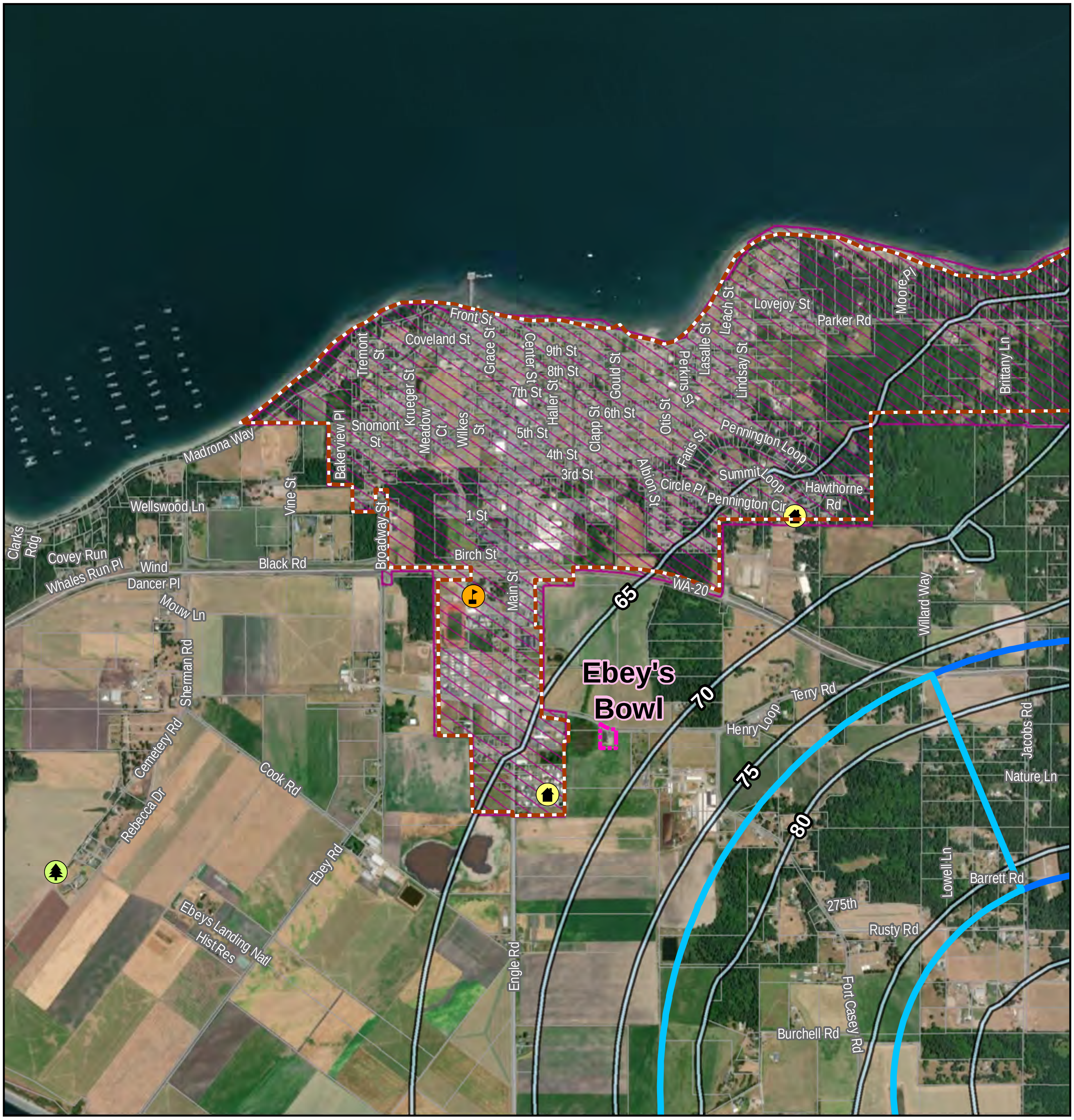


0 2,000 Feet

Legend

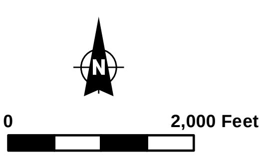
- Park
- Residential
- School
- Noise Contour (dB DNL)
- City/Town Boundary
- Non-Residential RAID
- Coupeville Urban Growth Area

Accident Potential Zones (APZs)

- APZ I
- APZ II

Figure 7-17
OLF Coupeville Area 2 Compatibility Concerns
OLF Coupeville
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.



Legend

- Residential
- Runway
- Noise Contour (dB DNL)
- Installation Area
- Residential RAID

Accident Potential Zones (APZs)

- Primary Surface
- Clear Zone
- APZ I
- APZ II

Figure 7-18
OLF Coupeville Area 3 Compatibility Concerns
OLF Coupeville
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

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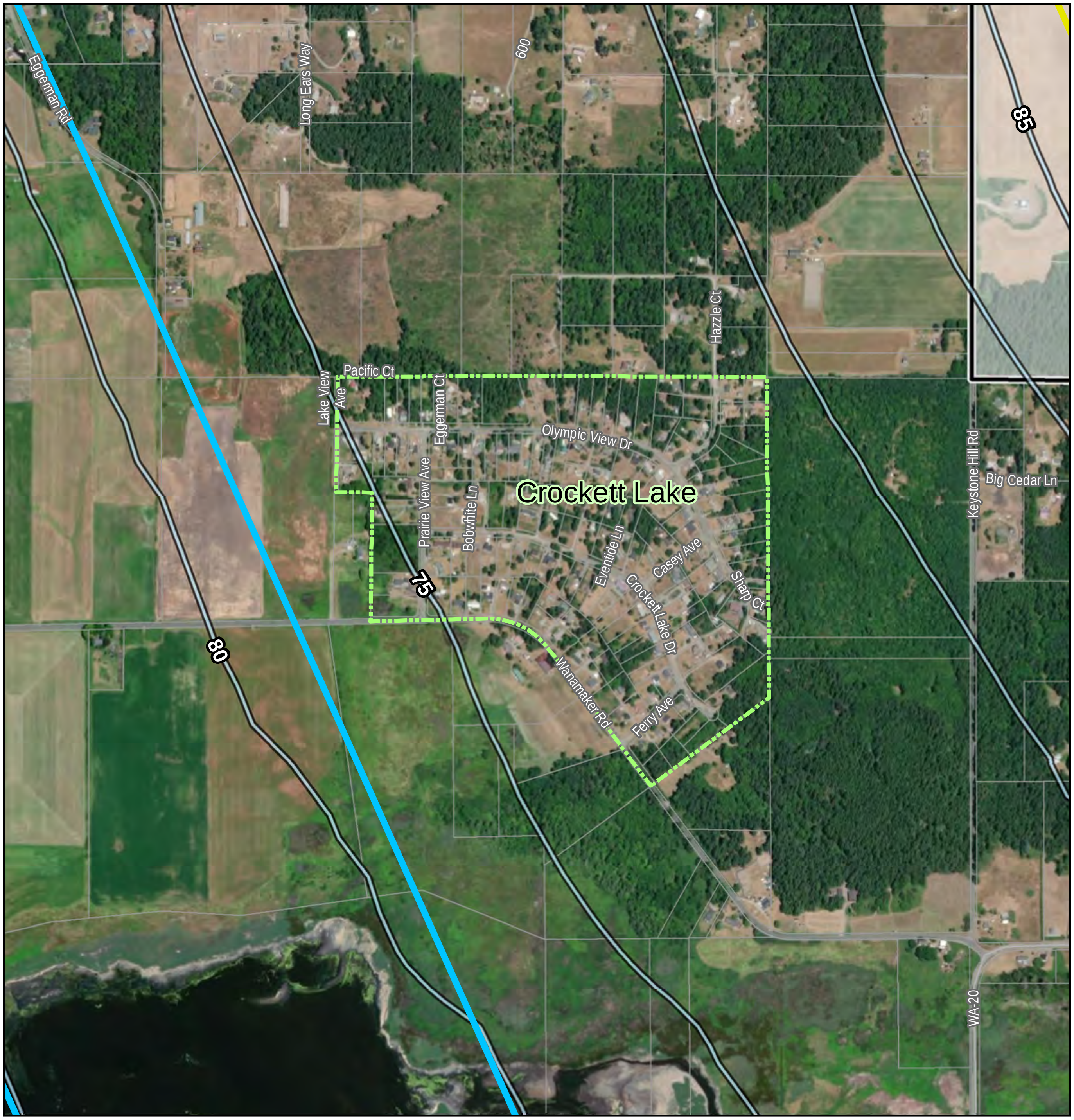

0 1,000 Feet

Legend

- Noise Contour (dB DNL)
- Installation Area
- Residential RAID

Accident Potential Zones (APZs)

- Primary Surface
- APZ II

Figure 7-19
OLF Coupeville Area 4
Compatibility Concerns
OLF Coupeville
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

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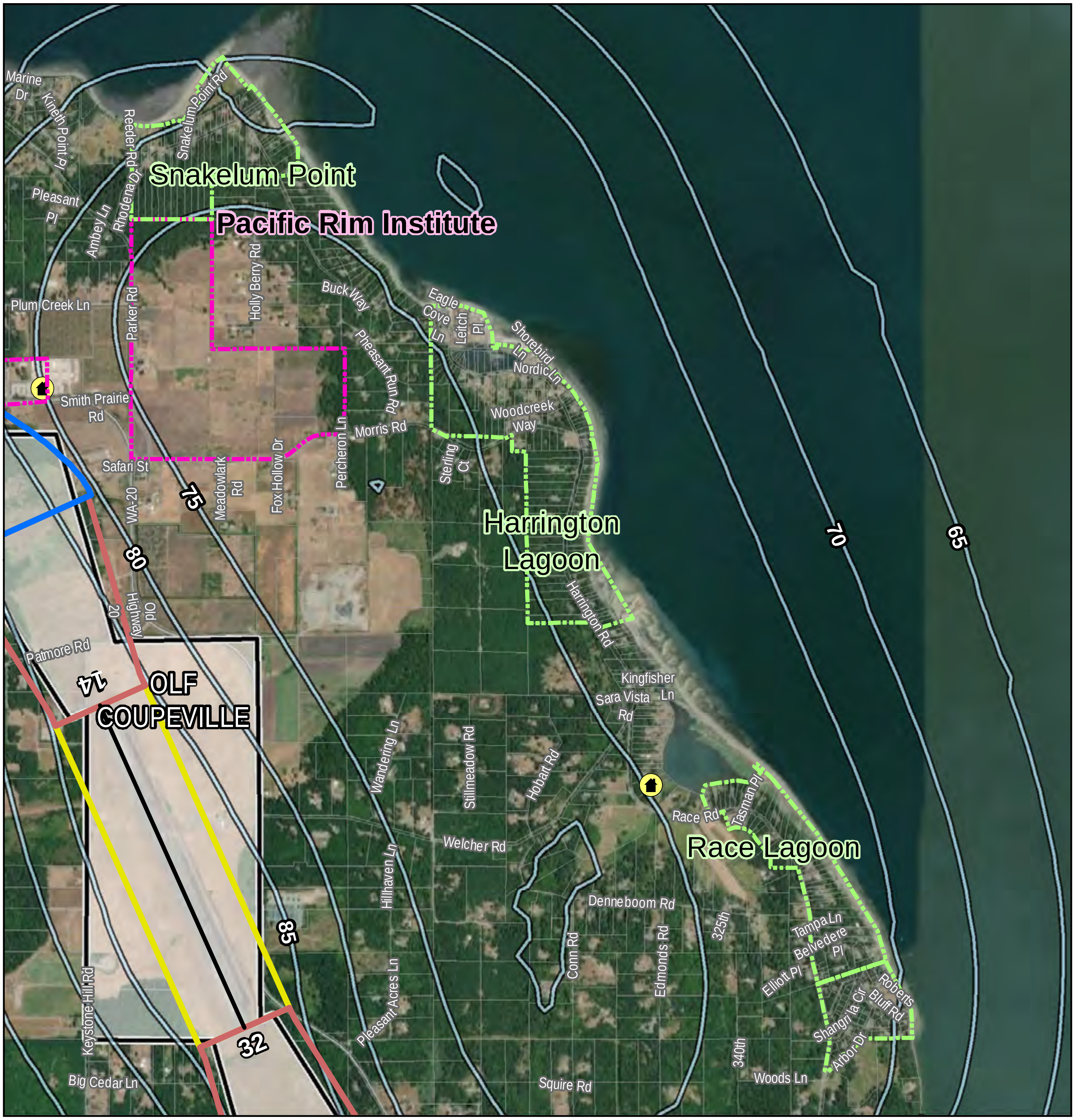

N

0 2,000 Feet

Legend

- Residential
- Runway
- Noise Contour (dB DNL)
- Installation Area
- Residential RAID
- Non-Residential RAID

Accident Potential Zones (APZs)

- Primary Surface
- Clear Zone
- APZ I

Figure 7-20
OLF Coupeville Area 5
Compatibility Concerns
OLF Coupeville
Whidbey Island,
Island County, WA

Source: NAS Whidbey Island 2020; ESRI 2020, 2016; Island County 2012; Ecology and Environment, Inc. 2020.

7.3 NASWI AICUZ Study Recommendations

Federal, state, and local governments; businesses; real estate professionals; and citizens, along with the Navy, all play an important role in the successful implementation of the AICUZ land use compatibility study. To effectively accomplish the goal of the AICUZ Program, all involved parties must have active participation. The following sections provide specific recommendations for NASWI personnel, as well as local governments and agencies, businesses, and private citizens, to implement to meet the goals of the AICUZ Program. These AICUZ Study recommendations, when implemented, will continue to advance the goal, to achieve compatibility between air installations and the community by encouraging compatible land uses that safeguard the installation's operational capabilities.

7.3.1 Navy Action Recommendations

The Navy has the responsibility to communicate and collaborate with local governments on land use planning, zoning, and compatibility concerns that can impact its mission. Mutual cooperation between NASWI and their neighboring communities is key to the AICUZ Program’s success. The following are recommendations to help meet the goals of the AICUZ Program, many of which are already implemented in some fashion.

- ❑ Maintain routine communication with local, state, and regional governments to be aware of any land use changes and to ensure the Navy’s input is offered in the early stages of any long-range planning initiatives.
- ❑ Continue to attend public hearings (meetings) and provide comments on actions that affect AICUZ planning for NASWI, including land use studies, CIP projects, comprehensive plan updates, and other land development regulation updates/amendments.
- ❑ Continue to engage in the Washington State Environmental Policy Act environmental review process and provide comments on Washington State Environmental Policy Act documents to disclose impacts to the NASWI mission, whether they relate to safety or noise, or to disclose to local decision makers that Navy operations may impact a project or future residents of a project.
- ❑ Provide community decision makers with the information and educational materials necessary to make informed decisions regarding the impact of their actions on mission readiness.
- ❑ Develop a package of AICUZ outreach materials, including community presentations and educational brochures, on military training activities and the Navy’s mission.
- ❑ Provide updated datasets and the updates from the AICUZ Study to local jurisdictions to ensure an awareness and understanding of the changes and how they may affect their local community.
- ❑ Encourage municipalities to promote the highest and best use of land by updating local zoning ordinances and building construction standards, especially for areas with noise exposure.
- ❑ Encourage municipalities to adopt legislative initiatives to acquire interest in developed properties in order to curb and mitigate encroachment near military installations and to protect the public from noise exposure and accident potential.

- ❑ Coordinate with the County, the City of Oak Harbor, and the Town of Coupeville in an effort to ensure that future annexations and changes to UGA or JPA boundaries do not negatively impact NASWI mission activities.
- ❑ Provide local real estate professionals with AICUZ-related materials and maps showing military training routes, MOAs, and AICUZ boundaries.
- ❑ Monitor the need to adjust operational procedures in order to reduce aircraft noise exposure (noise abatement) and potential mishaps; no changes that compromise the mission of the installation should be instituted.
- ❑ Work to expand the robust engagement effort with the local community.
- ❑ Continue use of an established noise complaint hotline to record and assess noise complaints and initiate resolution efforts as needed.
- ❑ Support any regional compatibility planning efforts, such as a Compatible Use Plan (CUP) funded by the DOD Office of Local Defense Community Cooperation (changed from Office of Economic Adjustment as part of the National Defense Authorization Action for Fiscal Year 2021).
- ❑ Execute existing REPI funding and pursue additional REPI funding to provide buffers for the base and to ensure long-term compatibility through the REPI Program.
- ❑ Incorporate the appropriate findings of the AICUZ Study into the NASWI Integrated Natural Resources Management Plan and the Installation Development Plan to address noise and safety concerns.
- ❑ To address existing incompatible land uses associated with the mobile home parks in APZ I for Runway 14/32 and in noise zones surrounding Ault Field, the Navy should work with local jurisdictions to communicate density recommendations.
- ❑ To address the potential future incompatible land uses associated with the future conversion of rural and agricultural land to residential and more intensive land uses within APZ and noise zones, the Navy should continue to monitor rezoning and subdivision applications within the AICUZ footprint.
- ❑ Work with the Island County Planning and Community Development Department and Planning Commission to revise the Airport and Aircraft Operations Noise Disclosure Ordinance (Island County Code of Ordinances Chapter 9.44) to require property owners to notify potential buyers and lessees if a property is located wholly or partially within an APZ.
- ❑ Continue to request that the local planning departments notify the NASWI CPLO when reviewing and approving conditional use permits related to parcels within the AICUZ footprint.
- ❑ Work with the Island County Planning and Community Development Department and Planning Commission to develop an aircraft operations noise overlay district to define permitted and conditional uses where noise exposure is greater than 65 dB DNL to limit the potential for future incompatible residential development in noise zones.
- ❑ Monitor rezoning and subdivision requests in northern areas of Oak Harbor and the unincorporated UGA to maintain awareness of potential incompatible residential development in noise zones.

- Continue to proactively communicate with the Pacific Rim Institute for Environmental Stewardship to stay informed on any future expansion of the campus, which could bring people-intensive uses and buildings within the AICUZ footprint.
- To address the existing incompatible land use associated with residential development in APZ I, north and south of OLF Coupeville, the Navy should work with local jurisdictions to ensure property owners, buyers, and renters are properly informed of the noise and safety zones.
- Continue to monitor the City of Oak Harbor's annexation actions within Island County and the potential expansion of their UGA or JPA.

7.3.2 State and Community Recommendations

State and local governments have the authority to implement regulations and programs to control development and direct growth to ensure land use activity is compatible within the AICUZ footprint. Local governments should recognize their responsibility in providing land use controls in those areas encumbered by the AICUZ footprint by incorporating AICUZ information into their planning policies and regulations. The following recommendations will support compatible development practices within the vicinity of the base.

- Local governments should continue to actively inform and request input from the installation regarding land use decisions that could impact the operational integrity of NASWI.
- Local governments, in coordination with the military, should continue to follow established protocols to notify NASWI regarding proposed developments to ensure adequate time to comment on proposed development prior to public review.
- Local governments should consider the need for regional compatibility planning through a CUP, Mission Growth Study, resilience study, or other assistance programs funded by the DOD Office of Local Defense Community Cooperation (changed from Office of Economic Adjustment as part of the National Defense Authorization Action for Fiscal Year 2021) or another planning mechanism or forum.
- Island County and the City of Oak Harbor should continue to evaluate and review all capital improvement projects in proximity to the airfield to determine potential direct and indirect impacts that such improvements may have on the AICUZ footprint.
- Island County should communicate to NASWI any proposed boundary changes for local UGAs and JPAs, incorporations, and/or annexations to encourage compatible land uses and policies.
- Island County should evaluate the need for residential RAID around the existing residential subdivision north of Ault Field at the intersection of Route 20 and West Banta Road to contain incompatible residential development in this area.
- Island County and the City of Oak Harbor should update their existing noise disclosure ordinances to reflect changes in the 2021 AICUZ noise contours and APZs.

- The Town of Coupeville should consider establishing a real estate disclosure district in areas where noise exposure exceeds 65 dB DNL to notify potential buyers and lessees of residences or residential parcels of noise levels.
- Real estate professionals should continue to remain diligent in disclosing noise exposure levels to prospective buyers or lessees to ensure they have all the available information concerning the noise environment and APZs prior to purchasing or leasing property near the airfield.
- It is recommended that real estate professionals continue to provide information about the AICUZ Study on their websites and provide a link to the NASWI website for information on aircraft operations.
- Citizens should provide sufficient and accurate information when registering a noise complaint with NASWI.

7.3.3 Summary of Implementing Land Use Tools and Recommendations for Areas of Compatibility Concerns

The goal of the Navy AICUZ Program can most effectively be accomplished by the active participation of all interested parties. Federal, state, regional, and local governments; planning organizations; businesses; real estate professionals; and citizens, along with the Navy, all play key roles in successfully implementing the goals of the AICUZ Program.

The Navy has the responsibility to communicate and collaborate with local governments on land use planning, zoning, and compatibility concerns that can affect its mission. NASWI is responsible for informing and educating community decision makers about the AICUZ Program; however, local governments should continue to actively inform and request input from NASWI regarding land use decisions that could impact the readiness of the installation. Local governments have the authority to implement regulations and programs to control development and direct growth to ensure land use activity is compatible with installation operations. Local governments should recognize their responsibility in providing land use control in areas encumbered by the AICUZ footprint by continuing to incorporate AICUZ information in their planning processes and regulations. Mutual cooperation between NASWI and neighboring communities is key to the AICUZ Program's success.

Table 7-8 illustrates how tools/recommendations and stakeholders can mitigate areas of compatibility concern. When combined, these tools and recommendations can have compounding effects on minimizing and addressing the concerns.

Table 7-8 summarizes areas of compatibility concern related to NASWI as well as land use tools and recommendations that are available for stakeholders to implement, as noted in both Section 6.2, Other Land Use Programs and Tools, and Section 7.3, NASWI AICUZ Study Recommendations. The table highlights examples of compatibility concerns that have been raised in this AICUZ Study and includes a suite of cumulative tools and recommendations that can be used to address these areas of concern.

To use this overview effectively, it is important to first understand the compatibility criteria that are explained in detail in Section 4.4, AICUZ Noise Contours, and Section 5.2, AICUZ Clear Zones and APZs. The compatibility criteria, along with the land use compatibility guidelines for the AICUZ footprint explained in Section 7.1, Guidelines and Classifications, provide a basis to identify the compatibility concerns for NASWI. This section provides a reference of the tools and recommendations for various groups of stakeholders to use to then address the concerns that were identified throughout Section 7.2.4, Compatibility Concerns.

Table 7-8 is not a comprehensive list of compatibility concerns and recommendations but, rather, for reference purposes, it provides an abbreviated list of the issues and recommendations that could be implemented to address compatibility concerns holistically. Each land use tool and recommendation is linked with multiple or specific areas of compatibility concern and provides a summary of recommended actions and options that could reduce the overall compatibility concerns at NASWI. Minimizing current compatibility concerns and alleviating future concerns involves active participation from several stakeholders often implementing one or more of the recommendations that address a specific area or a broader area of concern. Managing compatibility concerns is an ongoing process that requires monitoring, maintenance, and targeted planning. The left column highlights the overall areas of compatibility concern (i.e., noise zones and APZs). The second column discusses the various tools and recommendations that apply to the areas of compatibility. The third column highlights the stakeholder recommended to undertake the recommendation.

TABLE 7-8 COMPATIBLE LAND USE CONCERNS, TOOLS, AND RECOMMENDATIONS

AREA OF COMPATIBILITY CONCERN[1]	LAND USE TOOLS AND RECOMMENDATIONS	STAKEHOLDER
Ault Field: *Area 1* – Existing residential subdivision at the intersection of Route 20 and West Banta Road is within the 75 to 79-dB DNL noise zone and, therefore, incompatible. Future residential development is not encouraged. *Area 2* – The Dugualla Bay Heights residential RAID is within the 75 to 79-dB DNL and 80 to 84 dB-DNL noise zones and is considered incompatible. Portions are also within APZ II; therefore, lower development densities of 1 to 2 Du/Ac are recommended for future development. The Sunrise Hills residential RAID is located partially within the 65 to 69-dB and 70 to 74-dB DNL noise zones. The Navy discourages single-family residential development in these noise zones and future residential development is not recommended. *Area 3* – Multiple mobile home parks are located southeast of the airfield south of Pit Road and north of Fakkema Road and are incompatible due to noise exposure greater than 70 dB DNL. Two of the mobile home parks are also are located within APZ I. All	Continue to attend public hearings (meetings) and provide comments on actions that affect AICUZ planning for NASWI, including land use studies, CIP projects, comprehensive plan updates, and other land development regulation updates/amendments.	Federal/Navy
	Provide community decision makers with the information and educational materials necessary to make informed decisions regarding the impact of their actions on mission readiness.	Federal/Navy
	Develop a package of AICUZ outreach materials, including community presentations and educational brochures, on military training activities and the Navy's mission.	Federal/Navy
	Provide updated datasets and the updates from the AICUZ Study to local jurisdictions to ensure an awareness and understanding of the changes and how they may affect their local community.	Federal/Navy

TABLE 7-8 COMPATIBLE LAND USE CONCERNS, TOOLS, AND RECOMMENDATIONS

<table>
<tr><th>AREA OF COMPATIBILITY CONCERN[1]</th><th>LAND USE TOOLS AND RECOMMENDATIONS</th><th>STAKEHOLDER</th></tr>
<tr><td rowspan="10">residential development is recommended incompatible within this safety zone.

Area 4 – Land within Oak Harbor and the city's unincorporated UGA south of the airfield and north of Northeast 16th Avenue experiences noise exposure greater than 65 dB DNL. Incompatible uses in this area include single-family residences and mobile home parks along North Oak Harbor Road. A performing arts theater and a school are located within the 70 to 74-dB DNL contour range along with businesses and a restaurant in the 75 to 79-dB DNL contour range. These existing uses may be incompatible. Noise exposure should be considered for future development.

Area 5 – The Midget Market non-residential RAID is located within the 80 to 84-dB DNL noise contour range, as well as APZ I. This type of commercial use is considered incompatible in APZ I as well as the noise contour range. Future incompatible commercial uses should be discouraged in this RAID.

OLF Coupeville:

Area 1 – Development along Route 20 north of the airfield includes an animal shelter, transient lodging, a recreational association facility, a manufacturing facility, and an Island Transit facility. These uses wholly or partially experience noise exposure greater than 80 dB DNL, and some are located within APZ I. Existing manufacturing and residential development within this area is considered incompatible with federal guidelines. Motor vehicle facilities, such as the Island Transit facility, are considered compatible in the 80 to 84-dB DNL noise contour range if noise level reduction measures are taken in areas where the public is received, offices, and other noise sensitive areas. Transient lodgings, facilities housing animals, and cultural activities, like recreational associations, are considered incompatible within the 80 to 84-dB DNL noise contour range. Uses that concentrate groups of people, such as cultural activities and transient lodgings, are also incompatible in APZ I. The manufacturing facility's noise exposure is greater than 85 dB DNL. No developed land uses are considered compatible at that exposure level.

Area 2 – Southern portions of the town of Coupeville, including residential areas and Coupeville High School, are located within the 65 to 69-dB DNL contour range. While residences are recommended incompatible in this noise contour range, many communities allow development</td><td>Encourage municipalities to promote the highest and best use of land by updating local zoning ordinances and building construction standards, especially for noise exposure areas.</td><td>Federal/Navy</td></tr>
<tr><td>Provide local real estate professionals with AICUZ-related materials and maps showing military training routes, MOAs, and AICUZ boundaries.</td><td>Federal/Navy</td></tr>
<tr><td>Work to expand the robust engagement effort with the local community.</td><td>Federal/Navy</td></tr>
<tr><td>Continue use of the established noise complaint hotline to record and assess noise complaints and initiate resolution efforts as needed.</td><td>Federal/Navy</td></tr>
<tr><td>Support any regional compatibility planning efforts, such as a CUP funded by the DOD Office of Local Defense Community Cooperation.</td><td>Federal/Navy</td></tr>
<tr><td>Continue to actively inform and request input from NASWI regarding land use decisions that could impact the operational integrity of the installation.</td><td>Local Government</td></tr>
<tr><td>In coordination with the military, continue to follow established protocols to notify NASWI regarding proposed developments to ensure adequate time to comment on proposed development prior to public review.</td><td>Local Government</td></tr>
<tr><td>Consider the need for regional compatibility planning through a CUP, Mission Growth Study, resilience study, or other assistance programs funded by the DOD Office of Local Defense Community Cooperation or another planning mechanism or forum.</td><td>Local Government</td></tr>
<tr><td>Continue to evaluate and review all capital improvement projects in proximity to the airfield to determine potential direct and indirect impacts that such improvements may have on the AICUZ footprint.</td><td>Local Government</td></tr>
<tr><td>Communicate to NASWI any proposed boundary changes for local UGAs and JPAs, incorporations, and/or annexations to encourage compatible land uses and policies.</td><td>Local Government</td></tr>
</table>

TABLE 7-8 COMPATIBLE LAND USE CONCERNS, TOOLS, AND RECOMMENDATIONS

<table>
<tr><th>AREA OF COMPATIBILITY CONCERN[1]</th><th>LAND USE TOOLS AND RECOMMENDATIONS</th><th>STAKEHOLDER</th></tr>
<tr><td rowspan="6">in recognition of local need for housing. In these cases, it is recommended that noise level reduction measures are implemented to abate noise. Schools are considered compatible if noise level reduction measures are taken to reduce indoor noise levels by 25 dB.

Area 3 – The Admiral's Cove residential RAID experiences noise exposure greater than 75 dB DNL and portions are also located in APZ I. Residential uses in these noise and safety zones are considered incompatible and further residential development is not recommended in this area. A beach club is located on Keystone Avenue within APZ I and the 80 to 84-dB DNL noise contour range. Outdoor recreational activities are considered incompatible in this noise contour range.

Area 4 – The Crockett Lake residential RAID is within the 70 to 74-dB DNL noise contour range. Residential uses are considered incompatible and are discouraged within this noise contour range. No existing residences are currently within APZ II; however, expansion of this neighborhood to the west may place homes within the APZ. While single-family residences are considered compatible within APZ II, federal guidelines recommend residential development be low density (1 to 2 Du/Ac).

Area 5 –The Race Lagoon and Harrington Lagoon residential RAIDs are within the 75 to 79-dB DNL noise contour range. The Snakelum Point residential RAID is primarily located in the 75 to 79-dB DNL noise contour range, though parts are within the 80 to 84-dB DNL noise contour range. Existing residential development in these RAIDs is considered incompatible due to noise levels.</td><td>Island County should consider establishing a residential RAID around the existing residential subdivision north of Ault Field at the intersection of Route 20 and West Banta Road to contain incompatible residential development in this area.</td><td>Local Government</td></tr>
<tr><td>Island County and the City of Oak Harbor should update their existing noise disclosure ordinances to reflect changes in the 2021 AICUZ noise contours.</td><td>Local Government</td></tr>
<tr><td>The Town of Coupeville should consider establishing a real estate disclosure district in areas where noise exposure exceeds 65 dB DNL to notify potential buyers and lessees of residences or residential parcels of noise levels.</td><td>Local Government</td></tr>
<tr><td>Continue to remain diligent in disclosing noise exposure levels to prospective buyers or lessees to ensure they have all the available information concerning the noise environment and APZs prior to purchasing or leasing property near the airfield.</td><td>Real Estate Professionals</td></tr>
<tr><td>Continue to provide information about the AICUZ Study on their websites and provide a link to the NASWI website for information on aircraft operations.</td><td>Real Estate Professionals</td></tr>
<tr><td>Provide sufficient and accurate information when registering a noise complaint with NASWI.</td><td>Private Citizens</td></tr>
</table>

Note:
1 = See Section 7.2, Land Use Compatibility Analysis, for a detailed analysis of each area of compatibility concern

Key:
CIP = Capital Improvement Program
CUP = Compatible Use Plan
Du/Ac = dwelling units per acre
FCLP = Field Carrier Landing Practice
MOA = Military Operations Area
RAID = Rural Areas of More Intensive Development
REPI = Readiness and Environmental Protection Integration

8

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APPENDIX A

DISCUSSION OF NOISE AND ITS EFFECT ON THE ENVIRONMENT

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APPENDIX A — Discussion of Noise and Its Effect on the Environment

FINAL

WR 13-11

January 2014

APPENDIX A, NOISE EFFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE, SLEEP DISTURBANCE, HEARING IMPAIRMENT, HEALTH EFFECTS, APPENDIX A, NOISE EFECTS, SOUND LEVELS, SUPPLEMENTAL METRICS, ENVIRONMENT, HUMANS, ANNOYANCE, SPEECH INTEFERENCE,

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APPENDIX A – Discussion of Noise and Its Effect on the Environment

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Acronyms & Abbreviations

ID	Definition
AAD	Annual Average Daily
AGL	Above Ground Level
ANSI	American National Standards Institute
ASHLA	American Speech-Language-Hearing Association
CHABA	Committee on Hearing, Bioacousitcis, and Biomechanics
CNEL	Community Noise Equivalent Level
$CNEL_{mr}$	Onset-Rate Adjusted Monthly Community Noise Equivalent Level
dB	Decibel
dBA	A-Weighted Decibels
dB(A)	A-Weighted Decibels
DLR	German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt e.V.)
DNL	Day-Night Average Sound Level
DOD	Department of Defense
FAA	Federal Aviation Administration (US)
FICAN	Federal Interagency Committee on Aviation Noise
FICON	Federal Interagency Committee on Noise
HA	Highly Annoyed
HYENA	Hypertension and Exposure to Noise near Airports
Hz	Hertz
ISO	International Organization for Standardization
L	Sound Level
L_{dn}	Day-Night Average Sound Level
L_{dnmr}	Onset-Rate Adjusted Monthly Day-Night Average Sound Level
L_{eq}	Equivalent Sound Level
$L_{eq(16)}$	Equivalent Sound Level over 16 hours
$L_{eq(24)}$	Equivalent Sound Level over 24 hours
$L_{eq(30min)}$	Equivalent Sound Level over 30 minutes
$L_{eq(8)}$	Equivalent Sound Level over 8 hours
$L_{eq(h)}$	Hourly Equivalent Sound Level
L_{max}	Maximum Sound Level
L_{pk}	Peak Sound Level

(Continued on next page)

ID	Definition
m	meter (distance unit)
mmHg	millimeters of mercury
MOA	Military Operations Area
MTR	Military Training Route
NA	Number of Events At or Above a Selected Threshold
NATO	North Atlantic Treaty Organization
NDI	Noise Depreciation Index
NIPTS	Noise-induced Permanent Threshold Shift
NSDI	Noise Sensitivity Depreciation Index
OR	Odd Ratio
POI	Point of Interest
PTS	Permanent Threshold Shift
RANCH	Road Traffic and Aircraft Noise Exposure and Children's Cognition and Health
SEL	Sound Exposure Level
SIL	Speech Interference Level
SUA	Special Use Airspace
TA	Time Above
TTS	Temporary Threshold Shift
U.S.	United States
UKDfES	United Kingdom Department for Education and Skills
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WHO	World Health Organization

Appendix A

This appendix discusses sound and noise and their potential effects on the human and natural environment. Section A.1 provides an overview of the basics of sound and noise. Section A.2 defines and describes the different metrics used to describe noise. The largest section, Section A.3, reviews the potential effects of noise, focusing on effects on humans but also addressing effects on property values, terrain, structures, and animals. Section A.4 contains the list of references cited.

A.1 Basics of Sound

Section A.1.1 describes sound waves and decibels. Section A.1.2 review sounds levels and types of sounds.

A.1.1 Sound Waves and Decibels

Sound consists of minute vibrations in the air that travel through the air and are sensed by the human ear. Figure A-1 is a sketch of sound waves from a tuning fork. The waves move outward as a series of crests where the air is compressed and troughs where the air is expanded. The height of the crests and the depth of the troughs are the amplitude or sound pressure of the wave. The pressure determines its energy or intensity. The number of crests or troughs that pass a given point each second is called the frequency of the sound wave.

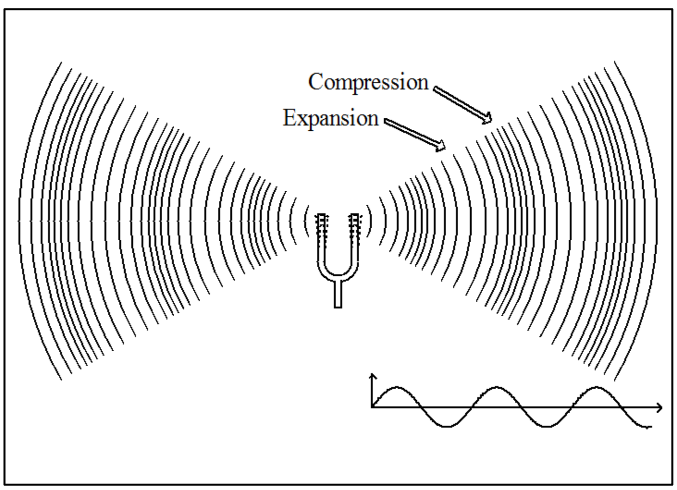


Figure A-1. Sound Waves from a Vibrating Tuning Fork

The measurement and human perception of sound involves three basic physical characteristics: intensity, frequency, and duration.

- Intensity is a measure of the acoustic energy of the sound and is related to sound pressure. The greater the sound pressure, the more energy carried by the sound and the louder the perception of that sound.

- Frequency determines how the pitch of the sound is perceived. Low-frequency sounds are characterized as rumbles or roars, while high-frequency sounds are typified by sirens or screeches.

- Duration or the length of time the sound can be detected.

As shown in Figure A-1, the sound from a tuning fork spreads out uniformly as it travels from the source. The spreading causes the sound's intensity to decrease with increasing distance from the source. For a source such as an aircraft in flight, the sound level will decrease by about 6 dB for every doubling of the distance. For a busy highway, the sound level will decrease by 3-4.5 dB for every doubling of distance.

As sound travels from the source it also gets absorbed by the air. The amount of absorption depends on the frequency composition of the sound, the temperature, and the humidity conditions. Sound with high frequency content gets absorbed by the air more than sound with low frequency content. More sound is absorbed in colder and drier conditions than in hot and wet conditions. Sound is also affected by wind and temperature gradients, terrain (elevation and ground cover) and structures.

The loudest sounds that can be comfortably heard by the human ear have intensities a trillion times higher than those of sounds barely heard. Because of this vast range, it is unwieldy to use a linear scale to represent the intensity of sound. 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 and 140 dB are felt as pain (Berglund and Lindvall 1995).

Because of the logarithmic nature of the decibel unit, sound levels cannot simply be 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, this process is often referred to as "decibel addition."

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. 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 the human ear does not respond linearly.

Sound frequency is measured in terms of cycles per second or hertz (Hz). The normal ear of a young person can detect sounds that range in frequency from about 20 Hz to 20,000 Hz. As we get older, we lose the ability to hear high frequency sounds. Not all sounds in this wide range of frequencies are heard equally. Human hearing is most sensitive to frequencies in the 1,000 to 4,000 Hz range. The notes on a piano range from just over 27 Hz to 4,186 Hz, with middle C equal to 261.6 Hz. Most sounds (including a single note on a piano) are not simple pure tones like the tuning fork in Figure A-1, but contain a mix, or spectrum, of many frequencies.

Sounds with different spectra are perceived differently even if the sound levels are the same. 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. These two curves, shown in Figure A-2, are adequate to quantify most environmental noises. A-weighting puts emphasis on the 1,000 to 4,000 Hz range.

Very loud or impulsive sounds, such as explosions or sonic booms, can sometimes be felt, and can cause secondary effects, such as shaking of a structure or rattling of windows. These types of sounds can add to annoyance, and are best measured by C-weighted sound levels, denoted dBC. C-weighting is nearly flat throughout the audible frequency range, and includes low frequencies that may not be heard but cause shaking or rattling. C-weighting approximates the human ear's sensitivity to higher intensity sounds.

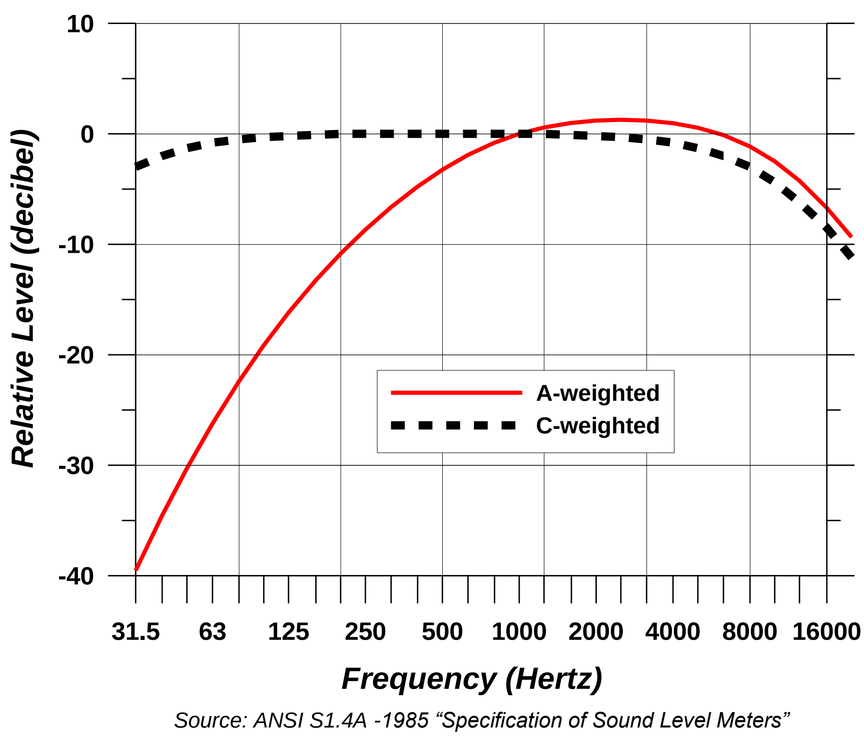


Figure A-2. Frequency Characteristics of A- and C-Weighting

A.1.2 Sound Levels and Types of Sounds

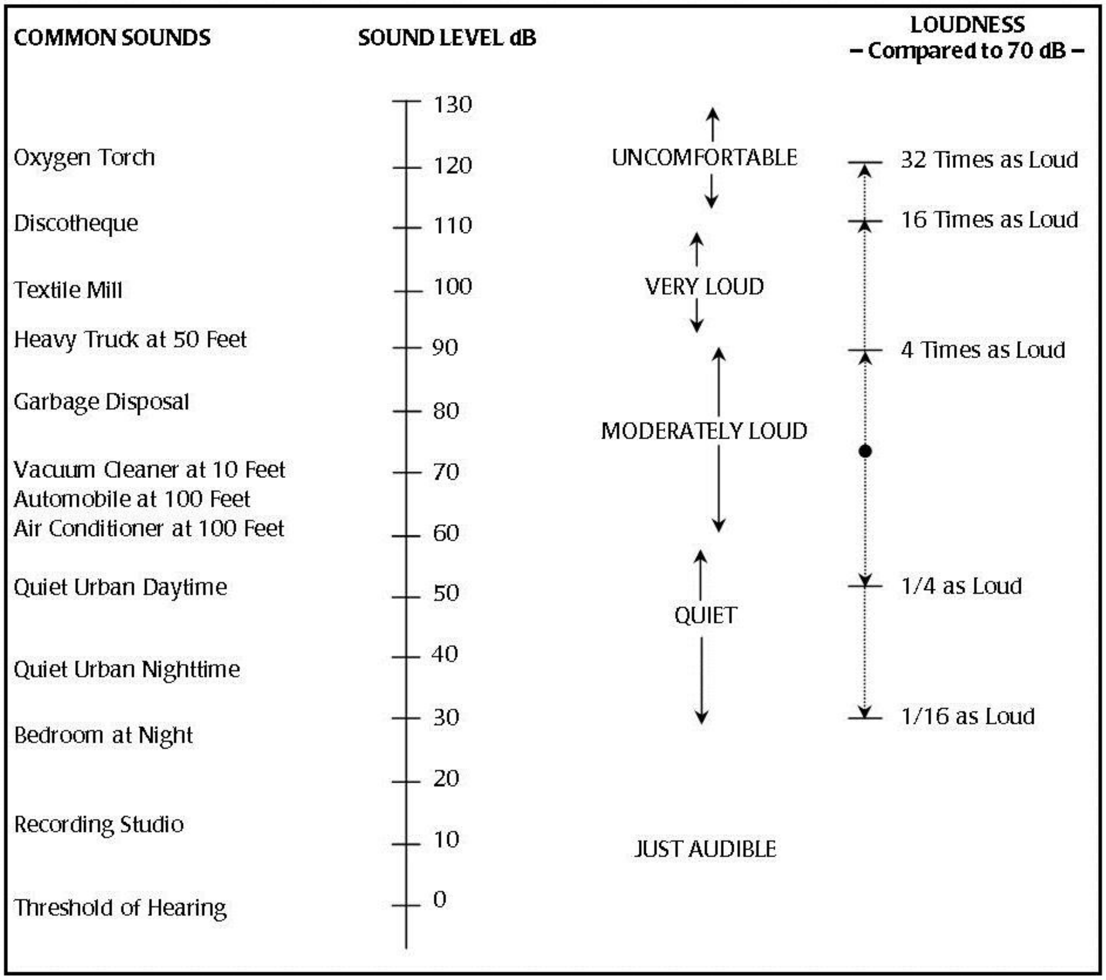
Most environmental sounds are measured using A-weighting. They're called A-weighted sound levels, and sometimes use the unit dBA or dB(A) rather than dB. When the use of A-weighting is understood, the term "A-weighted" is often omitted and the unit dB is used. Unless otherwise stated, dB units refer to A-weighted sound levels.

Sound becomes noise when it is unwelcome and interferes with normal activities, such as sleep or conversation. Noise is unwanted sound. Noise can become an issue when its level exceeds the ambient or background sound level. Ambient noise in urban areas typically varies from 60 to 70 dB, but can be as high as 80 dB in the center of a large city. Quiet suburban neighborhoods experience ambient noise levels around 45-50 dB (U.S. Environmental Protection Agency (USEPA) 1978).

Figure A-3 is a chart of A-weighted sound levels from common sources. Some sources, like the air conditioner and vacuum cleaner, are continuous sounds whose levels are constant for some time. Some sources, like the automobile and heavy truck, are the maximum sound during an intermittent event like a vehicle pass-by. Some sources like "urban daytime" and "urban nighttime" are averages over extended periods. A variety of noise metrics have been developed to describe noise over different time periods. These are discussed in detail in Section A.2.

Aircraft noise consists of two major types of sound events: flight (including takeoffs, landings and flyovers), and stationary, such as engine maintenance run-ups. The former are intermittent and the latter primarily continuous. Noise from aircraft overflights typically occurs beneath main approach and departure paths, in local air traffic patterns around the airfield, and in areas near aircraft parking ramps and staging areas. As aircraft climb, the noise received on the ground drops to lower levels, eventually fading into the background or ambient levels.

Impulsive noises are generally short, loud events. Their single-event duration is usually less than 1 second. Examples of impulsive noises are small-arms gunfire, hammering, pile driving, metal impacts during rail-yard shunting operations, and riveting. Examples of high-energy impulsive sounds are quarry/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, and any other explosive source where the equivalent mass of dynamite exceeds 25 grams (American National Standards Institute [ANSI] 1996).

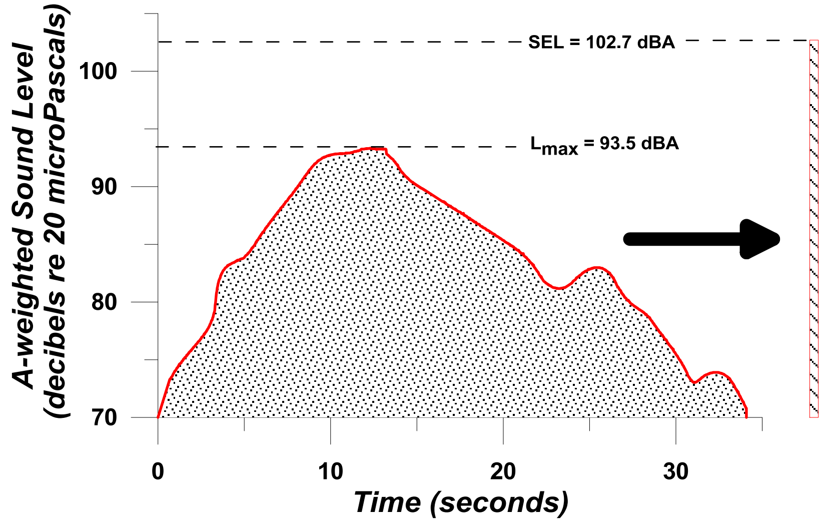


Sources: Harris 1979; Federal Interagency Committee on Aviation Noise (FICAN) 1997.

Figure A-3. Typical A-weighted Sound Levels of Common Sounds

A.2 Noise Metrics

Noise metrics quantify sounds so they can be compared with each other, and with their effects, in a standard way. The simplest metric is the A-weighted level, which is appropriate by itself for constant noise such as an air conditioner. Aircraft noise varies with time. During an aircraft overflight, noise starts at the background level, rises to a maximum level as the aircraft flies close to the observer, then returns to the background as the aircraft recedes into the distance. This is sketched in Figure A-4, which also indicates two metrics (L_{max} and SEL) that are described in Sections A.2.1 and A.2.3 below. Over time there can be a number of events, not all the same.



Source: Wyle Laboratories

Figure A-4. Example Time History of Aircraft Noise Flyover

There are a number of metrics that can be used to describe a range of situations, from a particular individual event to the cumulative effect of all noise events over a long time. This section describes the metrics relevant to environmental noise analysis.

A.2.1 Single-events

Maximum Sound Level (L_{max})

The highest A-weighted sound level measured during a single event in which the sound changes with time is called the maximum A-weighted sound level or Maximum Sound Level and is abbreviated L_{max}. The L_{max} is depicted for a sample event in Figure A-4.

L_{max} is the maximum level that occurs over a fraction of a second. For aircraft noise, the "fraction of a second" is one-eighth of a second, denoted as "fast" response on a sound level measuring meter (ANSI 1988). Slowly varying or steady sounds are generally measured over 1 second, denoted "slow" response. L_{max} is important in judging if a noise event will interfere with conversation, TV or radio listening, or other common activities. Although it provides some measure of the event, it does not fully describe the noise, because it does not account for how long the sound is heard.

Peak Sound Pressure Level (L_{pk})

The Peak Sound Pressure Level is the highest instantaneous level measured by a sound level measurement meter. L_{pk} is typically measured every 20 microseconds, and usually based on unweighted or linear response of the meter. It is used to describe individual impulsive events such as blast noise. Because blast noise varies from shot to shot and varies with meteorological (weather) conditions, the U.S. Department of Defense (DOD) usually characterizes L_{pk} by the metric PK 15(met), which is the L_{pk} exceeded 15% of the time. The "met" notation refers to the metric accounting for varied meteorological or weather conditions.

Sound Exposure Level (SEL)

Sound Exposure Level combines both the intensity of a sound and its duration. For an aircraft flyover, SEL includes the maximum and all lower noise levels produced as part of the overflight, together with how long each part lasts. It represents the total sound energy in the event. Figure A-4 indicates the SEL for an example event, representing it as if all the sound energy were contained within 1 second.

Because aircraft noise events last more than a few seconds, the SEL value is larger than L_{max}. It does not directly represent the sound level heard at any given time, but rather the entire event. SEL provides a much better measure of aircraft flyover noise exposure than L_{max} alone.

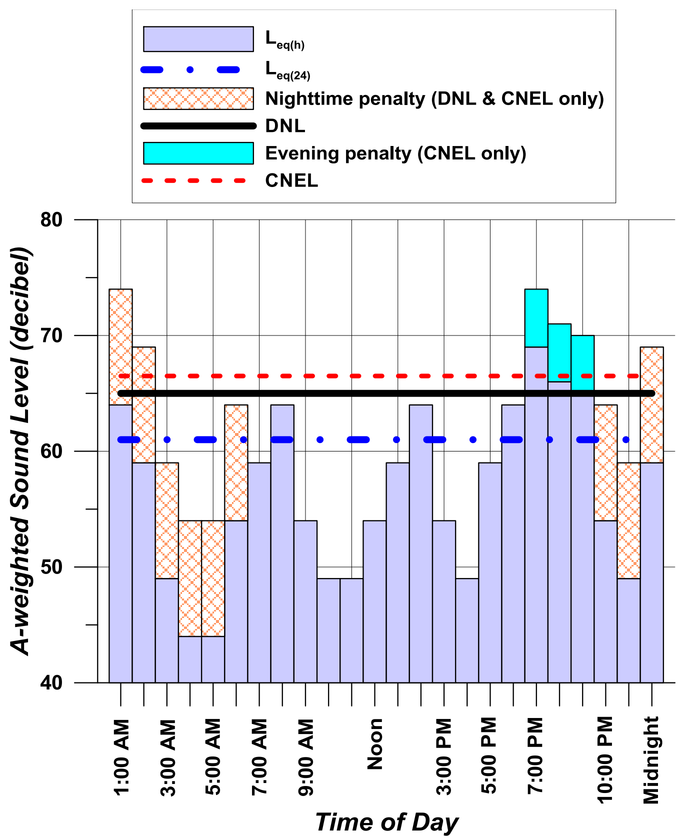
A.2.2 Cumulative Events

Equivalent Sound Level (L_{eq})

Equivalent Sound Level is a "cumulative" metric that combines a series of noise events over a period of time. L_{eq} is the sound level that represents the decibel average SEL of all sounds in the time period. Just as SEL has proven to be a good measure of a single event, L_{eq} has proven to be a good measure of series of events during a given time period.

The time period of an L_{eq} measurement is usually related to some activity, and is given along with the value. The time period is often shown in parenthesis (e.g., $L_{eq(24)}$ for 24 hours). The L_{eq} from 7 a.m. to 3 p.m. may give exposure of noise for a school day.

Figure A-5 gives an example of $L_{eq(24)}$ using notional hourly average noise levels ($L_{eq(h)}$) for each hour of the day as an example. The $L_{eq(24)}$ for this example is 61 dB.



Source: Wyle Laboratories

Figure A-5. Example of $L_{eq(24)}$, DNL and CNEL Computed from Hourly Equivalent Sound Levels

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

Day-Night Average Sound Level is a cumulative metric that accounts for all noise events in a 24-hour period. However, unlike $L_{eq(24)}$, DNL contains a nighttime noise penalty. To account for our increased sensitivity to noise at night, DNL applies a 10 dB penalty to events during the nighttime period, defined as 10:00 p.m. to 7:00 a.m. The notations DNL and L_{dn} are both used for Day-Night Average Sound Level and are equivalent.

CNEL is a variation of DNL specified by law in California (California Code of Regulations Title 21, *Public Works*) (Wyle Laboratories 1970). CNEL has the 10 dB nighttime penalty for events between 10:00 p.m. and 7:00 a.m. but also includes a 4.8 dB penalty for events during the evening period of 7:00 p.m. to 10:00 p.m. The evening penalty in CNEL accounts for the added intrusiveness of sounds during that period.

For airports and military airfields, DNL and CNEL represent the average sound level for annual average daily aircraft events.

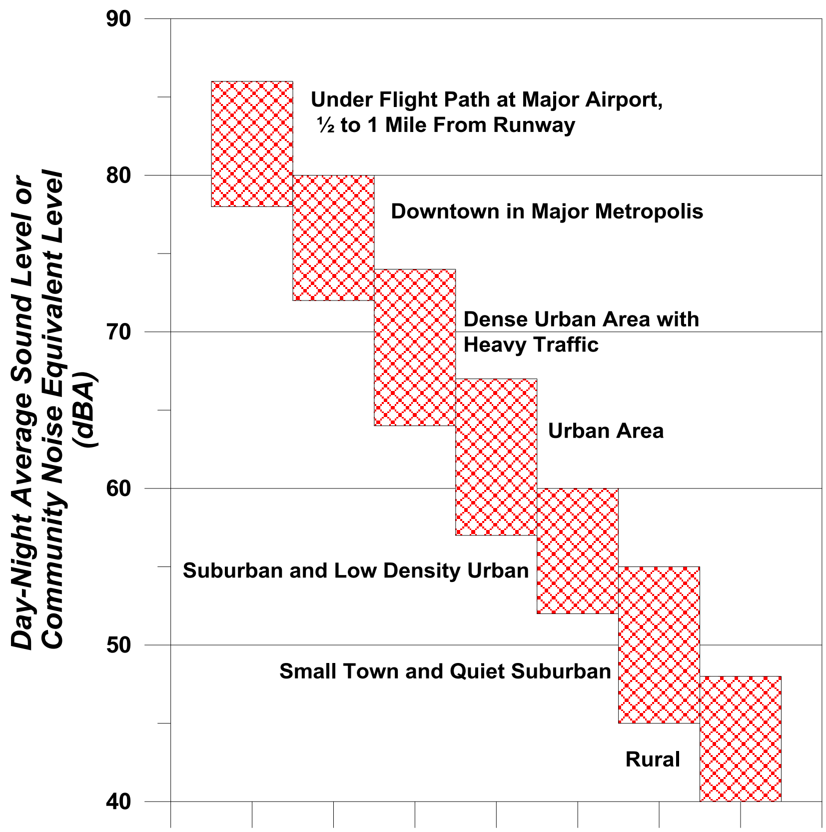
Figure A-5 gives an example of DNL and CNEL using notional hourly average noise levels ($L_{eq(h)}$) for each hour of the day as an example. Note the $L_{eq(h)}$ for the hours between 10 p.m. and 7 a.m. have a 10 dB penalty assigned. For CNEL the hours between 7p.m. and 10 p.m. have a 4.8 dB penalty assigned. The DNL for this example is 65 dB. The CNEL for this example is 66 dB.

Figure A-6 shows the ranges of DNL or CNEL that occur in various types of communities. Under a flight path at a major airport the DNL may exceed 80 dB, while rural areas may experience DNL less than 45 dB.

The decibel summation nature of these metrics causes the noise levels of the loudest events to control the 24-hour average. As a simple example, consider a case in which only one aircraft overflight occurs during the daytime over a 24-hour period, creating a sound level of 100 dB for 30 seconds. During the remaining 23 hours, 59 minutes, and 30 seconds of the day, the ambient sound level is 50 dB. The DNL for this 24-hour period is 65.9 dB. Assume, as a second example that 10 such 30-second overflights occur during daytime hours during the next 24-hour period, with the same ambient sound level of 50 dB during the remaining 23 hours and 55 minutes of the day. The DNL for this 24-hour period is 75.5 dB. Clearly, the averaging of noise over a 24-hour period does not ignore the louder single events and tends to emphasize both the sound levels and number of those events.

A feature of the DNL metric is that a given DNL value could result from a very few noisy events or a large number of quieter events. For example, 1 overflight at 90 dB creates the same DNL as 10 overflights at 80 dB.

DNL or CNEL do not represent a level heard at any given time, but represent long term exposure. Scientific studies have found good correlation between the percentages of groups of people highly annoyed and the level of average noise exposure measured in DNL (Schultz 1978; USEPA 1978).



Source: DOD 1978.

Figure A-6. Typical DNL or CNEL Ranges in Various Types of Communities

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

Military aircraft utilizing Special Use Airspace (SUA) such as Military Training Routes (MTRs), Military Operations Areas (MOAs), and Restricted Areas/Ranges generate a noise environment that is somewhat different from that around airfields. Rather than regularly occurring operations like at airfields, activity in SUAs is highly sporadic. It is often seasonal, ranging from 10 per hour to less than 1 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, with rates of up to 150 dB per second.

The cumulative daily noise metric devised to account for the "surprise" effect of the sudden onset of aircraft noise events on humans and the sporadic nature of SUA activity is the Onset-Rate Adjusted Monthly Day-Night Average Sound Level (L_{dnmr}). Onset rates between 15 and 150 dB per second require an adjustment of 0 to 11 dB to the event's SEL, while onset rates below 15 dB per second require no adjustment to the event's SEL (Stusnick et al. 1992). The term 'monthly' in L_{dnmr} refers to the noise assessment being conducted for the month with the most operations or sorties -- the so-called busiest month.

In 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.2.3 Supplemental Metrics

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

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

NA is a supplemental metric. It is not supported by the amount of science behind DNL/CNEL, but it is valuable in helping to describe noise to the community. A threshold level and metric are selected that best meet the need for each situation. An L_{max} threshold is normally selected to analyze speech interference, while an SEL threshold is normally selected for analysis of sleep disturbance.

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

Time Above (TA) a Specified Level (L)

The Time Above (TA) metric is the total time, in minutes, that the A-weighted noise level is at or above a threshold. Combined with the threshold level (L), it is denoted TAL. TA can be calculated over a full 24-hour annual average day, the 15-hour daytime and 9-hour nighttime periods, a school day, or any other time period of interest, provided there is operational data for that time.

TA is a supplemental metric, used to help understand noise exposure. It is useful for describing the noise environment in schools, particularly when assessing classroom or other noise sensitive areas for various scenarios. TA can be shown as contours on a map similar to the way DNL contours are drawn.

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

A.3 Noise Effects

Noise is of concern because of potential adverse effects. The following subsections describe how noise can affect communities and the environment, and how those effects are quantified. The specific topics discussed are:

- Annoyance;
- Speech interference;
- Sleep disturbance;
- Noise-induced hearing impairment;
- Non-auditory health effects;
- Performance effects;
- Noise effects on children;
- Property values;
- Noise-induced vibration effects on structures and humans;
- Noise effects on terrain;
- Noise effects on historical and archaeological sites; and
- Effects on domestic animals and wildlife.

A.3.1 Annoyance

With the introduction of jet aircraft in the 1950s, it became clear that aircraft noise annoyed people and was a significant problem around airports. Early studies, such as those of Rosenblith et al. (1953) and Stevens et al. (1953) showed that effects depended on the quality of the sound, its level, and the number of flights. Over the next 20 years considerable research was performed refining this understanding and setting guidelines for noise exposure. In the early 1970s, the USEPA published its "Levels Document" (USEPA 1974) that reviewed the factors that affected communities. DNL (still known as L_{dn} at the time) was identified as an appropriate noise metric, and threshold criteria were recommended.

Threshold criteria for annoyance were identified from social surveys, where people exposed to noise were asked how noise affects them. Surveys provide direct real-world data on how noise affects actual residents.

Surveys in the early years had a range of designs and formats, and needed some interpretation to find common ground. In 1978, Schultz showed that the common ground was the number of people "highly annoyed," defined as the upper 28% range of whatever response scale a survey used (Schultz 1978). With that definition, he was able to show a remarkable consistency among the majority of the surveys for which data were available. Figure A-7 shows the result of his study relating DNL to individual annoyance measured by percent highly annoyed (%HA).

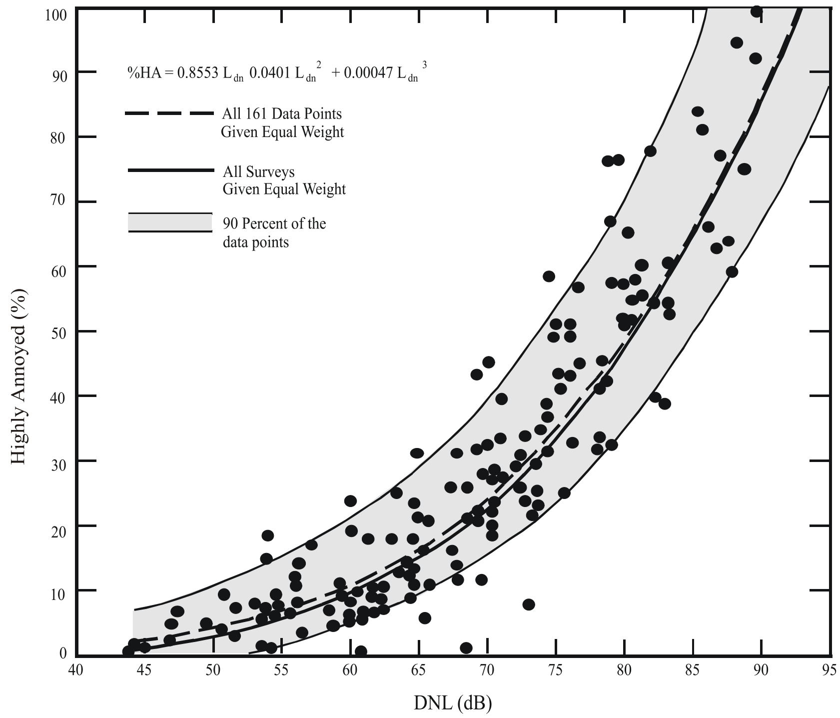


Figure A-7. Schultz Curve Relating Noise Annoyance to DNL (Schultz 1978)

Schultz's original synthesis included 161 data points. Figure A-8 compares revised fits of the Schultz data set with an expanded set of 400 data points collected through 1989 (Finegold et al. 1994). The new form is the preferred form in the US, endorsed by the Federal Interagency Committee on Aviation Noise (FICAN 1997). Other forms have been proposed, such as that of Fidell and Silvati (2004), but have not gained widespread acceptance.

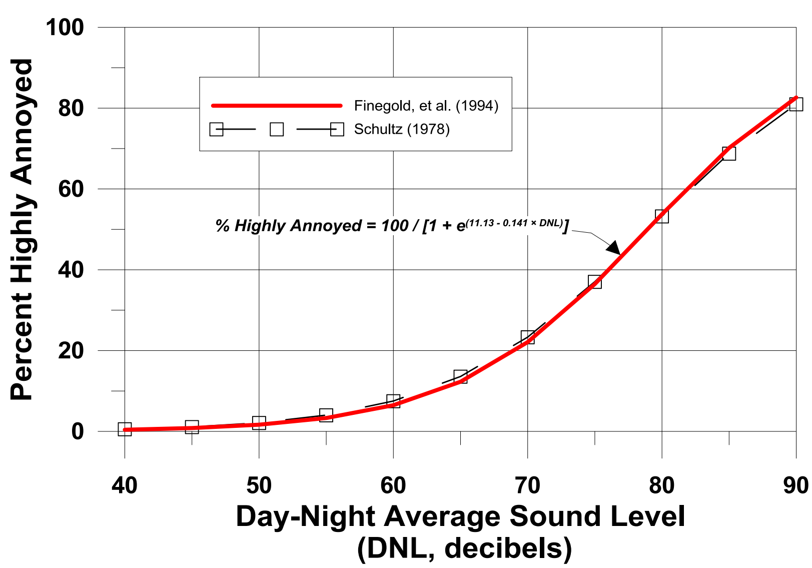


Figure A-8. Response of Communities to Noise; Comparison of Original Schultz (1978) with Finegold et al (1994)

When the goodness of fit of the Schultz curve is examined, the correlation between groups of people is high, in the range of 85-90%. The correlation between individuals is lower, 50% or less. This is not surprising, given the personal differences between individuals. The surveys underlying the Schultz curve include results that show that annoyance to noise is also affected by non-acoustical factors. Newman and Beattie (1985) divided the non-acoustic factors into the emotional and physical variables shown in Table A-1.

Table A-1. Non-Acoustic Variables Influencing Aircraft Noise Annoyance

Emotional Variables
Feeling about the necessity or preventability of the noise;
Judgement 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;
Predicitabiltiy of the noise;
Control over the noise source; and
Length of time individual is exposed to a noise.

Schreckenberg and Schuemer (2010) recently examined the importance of some of these factors on short term annoyance. Attitudinal factors were identified as having an effect on annoyance. In formal regression analysis, however, sound level (L_{eq}) was found to be more important than attitude.

A recent study by Plotkin et al. (2011) examined updating DNL to account for these factors. It was concluded that the data requirements for a general analysis were much greater than most existing studies. It was noted that the most significant issue with DNL is that it is not readily understood by the public, and that supplemental metrics such as TA and NA were valuable in addressing attitude when communicating noise analysis to communities (DOD 2009a).

A factor that is partially non-acoustical is the source of the noise. Miedema and Vos (1998) presented synthesis curves for the relationship between DNL and percentage "Annoyed" and percentage "Highly Annoyed" for three transportation noise sources. Different curves were found for aircraft, road traffic, and railway noise. Table A-2 summarizes their results. Comparing the updated Schultz curve suggests that the percentage of people highly annoyed by aircraft noise may be higher than previously thought.

Table A-2. Percent Highly Annoyed for Different Transportation Noise Sources

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

Source: Miedema and Vos 1998.

As noted by the World Health Organization (WHO), however, even though aircraft noise seems to produce a stronger annoyance response than road traffic, caution should be exercised when interpreting synthesized data from different studies (WHO 1999).

Consistent with WHO's recommendations, the Federal Interagency Committee on Noise (FICON 1992) considered the Schultz curve to be the best source of dose information to predict community response to noise, but recommended further research to investigate the differences in perception of noise from different sources.

A.3.2 Speech Interference

Speech interference from noise is a primary cause of annoyance for communities. Disruption of routine activities such as radio or television listening, telephone use, or conversation leads to frustration and annoyance. The quality of speech communication is important in classrooms and offices. In the workplace, speech interference from noise can cause fatigue and vocal strain in those who attempt to talk over the noise. In schools it can impair learning.

There are two measures of speech comprehension:

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

U.S. Federal Criteria for Interior Noise

In 1974, the USEPA identified a goal of an indoor $L_{eq(24)}$ of 45 dB to minimize speech interference based on sentence intelligibility and the presence of steady noise (USEPA 1974). Figure A-9 shows the effect of steady indoor background sound levels on sentence intelligibility. For an average adult with normal hearing and fluency in the language, steady background indoor sound levels of less than 45 dB L_{eq} are expected to allow 100% sentence intelligibility.

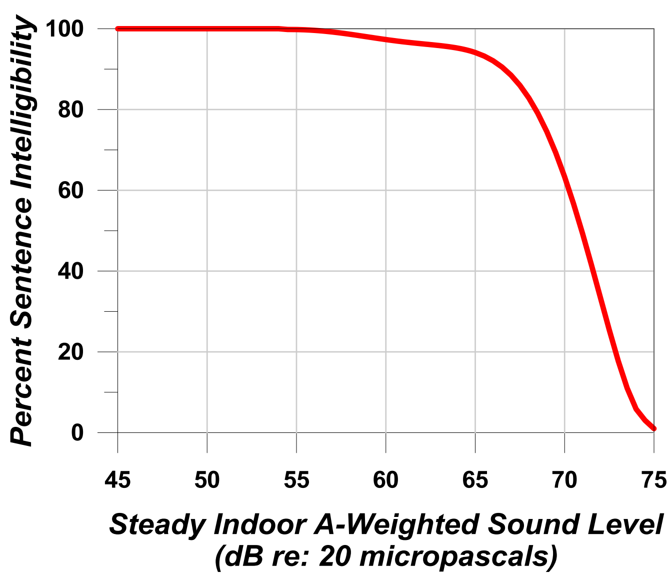


Figure A-9. Speech Intelligibility Curve (digitized from USEPA 1974)

The curve in Figure A-9 shows 99% intelligibility at L_{eq} below 54 dB, and less than 10% above 73 dB. Recalling that L_{eq} is dominated by louder noise events, the USEPA $L_{eq(24)}$ goal of 45 dB generally ensures that sentence intelligibility will be high most of the time.

Classroom Criteria

For teachers to be understood, their regular voice must be clear and uninterrupted. Background noise has to be below the teacher's voice level. Intermittent noise events that momentarily drown out the teacher's voice need to be kept to a minimum. It is therefore important to evaluate the steady background level, the level of voice communication, and the single-event level due to aircraft overflights that might interfere with speech.

Lazarus (1990) found that for listeners with normal hearing and fluency in the language, complete sentence intelligibility can be achieved when the signal-to-noise ratio (i.e., a comparison of the level of the sound to the level of background noise) is in the range of 15 to 18 dB. The initial ANSI classroom noise standard (ANSI 2002) and American Speech-Language-Hearing Association (ASLHA 1995) guidelines concur, recommending at least a 15 dB signal-to-noise ratio in classrooms. If the teacher's voice level is at least 50 dB, the background noise level must not exceed an average of 35 dB. The National Research Council of Canada (Bradley 1993) and WHO (1999) agree with this criterion for background noise.

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

Most aircraft noise is not continuous. It consists of individual events like the one sketched in Figure A-4. Since speech interference in the presence of aircraft noise is caused by individual aircraft flyover events, a time-averaged metric alone, such as L_{eq}, is not necessarily appropriate. In addition to the background level criteria described above, single-event criteria that account for those noisy events are also needed.

A 1984 study by Wyle for the Port Authority of New York and New Jersey recommended using Speech Interference Level (SIL) for classroom noise criteria (Sharp and Plotkin 1984). SIL is based on the maximum sound levels in the frequency range that most affects speech communication (500-2,000 Hz). The study identified an SIL of 45 dB as the goal. This would provide 90% word intelligibility for the short time periods during aircraft overflights. While SIL is technically the best metric for speech interference, it can be approximated by an L_{max} value. An SIL of 45 dB is equivalent to an A-weighted L_{max} of 50 dB for aircraft noise (Wesler 1986).

Lind et al. (1998) also concluded that an L_{max} criterion of 50 dB would result in 90% word intelligibility. Bradley (1985) recommends SEL as a better indicator. His work indicates that 95% word intelligibility would be achieved when indoor SEL did not exceed 60 dB. For typical flyover noise this corresponds to an L_{max} of 50 dB. While WHO (1999) only specifies a background L_{max} criterion, they also note the SIL frequencies and that interference can begin at around 50 dB.

The United Kingdom Department for Education and Skills (UKDfES) established in its classroom acoustics guide a 30-minute time-averaged metric of $L_{eq(30min)}$ for background levels and the metric of $L_{A1,30min}$ for intermittent noises, at thresholds of 30-35 dB and 55 dB, respectively. $L_{A1,30min}$ represents the A-weighted sound level that is exceeded 1% of the time (in this case, during a 30-minute teaching session) and is generally equivalent to the L_{max} metric (UKDfES 2003).

Table A-3 summarizes the criteria discussed. Other than the FAA (1985) 45 dB L_{max} criterion, they are consistent with a limit on indoor background noise of 35-40 dB L_{eq} and a single event limit of 50 dB L_{max}. It should be noted that these limits were set based on students with normal hearing and no special needs. At-risk students may be adversely affected at lower sound levels.

Table A-3. Indoor Noise Level Criteria Based on Speech Intelligibility

Source	Metric/Level (dB)	Effects and Notes
U.S. FAA (1985)	$L_{eq(during\ school\ hours)}$ = 45 dB	Federal assistance criteria for school sound insulation; supplemental single-event criteria may be used.
Lind et al. (1998), Sharp and Plotkin (1984), Wesler (1986)	L_{max} = 50 dB / SIL 45	Single event level permissible in the classroom.
WHO (1999)	L_{eq} = 35 dB L_{max} = 50 dB	Assumes average speech level of 50 dB and recommends signal to noise ratio of 15 dB.
U.S. ANSI (2010)	L_{eq} = 35 dB, based on Room Volume (e.g., cubic feet)	Acceptable background level for continuous and intermittent noise.
U.K. DFES (2003)	$L_{eq(30min)}$ = 30-35 dB L_{max} = 55 dB	Minimum acceptable in classroom and most other learning environs.

A.3.3 Sleep Disturbance

Sleep disturbance is a major concern for communities exposed to aircraft noise at night. A number of studies have attempted to quantify the effects of noise on sleep. This section provides an overview of the major noise-induced sleep disturbance studies. Emphasis is on studies that have influenced U.S. federal noise policy. The studies have been separated into two groups:

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

Initial Studies

The relation between noise and sleep disturbance is complex and not fully understood. The disturbance depends not only on the depth of sleep and the noise level, but also on the non-acoustic factors cited for annoyance. The easiest effect to measure is the number of arousals or awakenings from noise events. Much of the literature has therefore focused on predicting the percentage of the population that will be awakened at various noise levels.

FICON's 1992 review of airport noise issues (FICON 1992) included an overview of relevant research conducted through the 1970s. Literature reviews and analyses were conducted from 1978 through 1989 using existing data (Griefahn 1978; Lukas 1978; Pearsons et. al. 1989). Because of large variability in the data, FICON did not endorse the reliability of those results.

FICON did, however, recommend an interim dose-response curve, awaiting future research. That curve predicted the percent of the population expected to be awakened as a function of the exposure to SEL. This curve was based on research conducted for the U.S. Air Force (Finegold 1994). The data included most of the research performed up to that point, and predicted a 10% probability of awakening when exposed to an interior SEL of 58 dB. The data used to derive this curve were primarily from controlled laboratory studies.

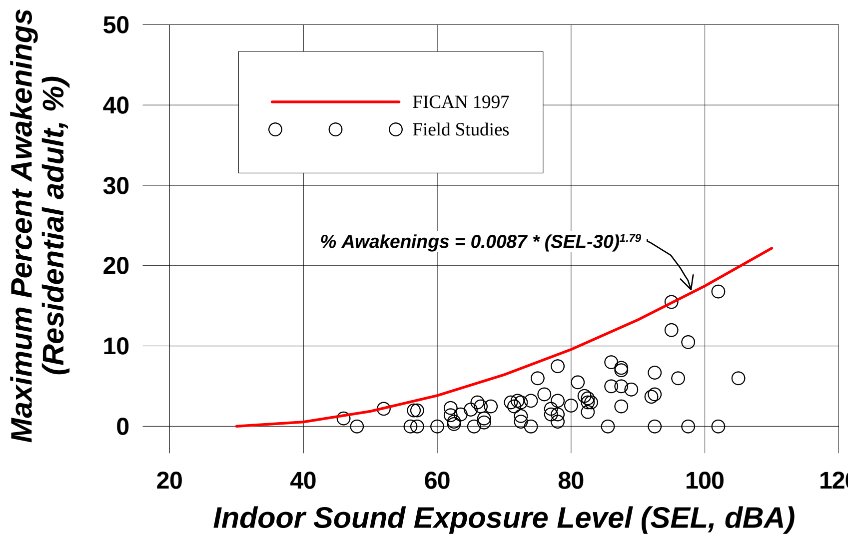
Recent Sleep Disturbance Research – Field and Laboratory Studies

It was noted that early sleep laboratory studies did not account for some important factors. These included habituation to the laboratory, previous exposure to noise, and awakenings from noise other than aircraft. In the early 1990s, field studies in people's homes were conducted to validate the earlier laboratory work conducted in the 1960s and 1970s. The field studies of the 1990s found that 80-90% of sleep disturbances were not related to outdoor noise events, but rather to indoor noises and non-noise factors. The results showed that, in real life conditions, there was less of an effect of noise on sleep than had been previously reported from laboratory studies. Laboratory sleep studies tend to show more sleep disturbance than field studies because people who sleep in their own homes are used to their environment and, therefore, do not wake up as easily (FICAN 1997).

FICAN

Based on this new information, in 1997 FICAN recommended a dose-response curve to use instead of the earlier 1992 FICON curve (FICAN 1997). Figure A-10 shows FICAN's curve, the red line, which is based on the results of three field studies shown in the figure (Ollerhead et al. 1992; Fidell et al. 1994; Fidell et al. 1995a, 1995b), along with the data from six previous field studies.

The 1997 FICAN curve represents the upper envelope of the latest field data. It predicts the maximum percent awakened for a given residential population. According to this curve, a maximum of 3% of people would be awakened at an indoor SEL of 58 dB. An indoor SEL of 58 dB is equivalent to an outdoor SEL of 83 dB, with the windows closed (73 dB with windows open).



Source: FICAN 1997

Figure A-10. FICAN 1997 Recommended Sleep Disturbance Dose-Response Relationship

Number of Events and Awakenings

It is reasonable to expect that sleep disturbance is affected by the number of events. The German Aerospace Center (DLR Laboratory) conducted an extensive study focused on the effects of nighttime aircraft noise on sleep and related factors (Basner 2004). The DLR study was one of the largest studies to examine the link between aircraft noise and sleep disturbance. It involved both laboratory and in-home field research phases. The DLR investigators developed a dose-response curve that predicts the number of aircraft events at various values of L_{max} expected to produce one additional awakening over the course of a night. The dose-effect curve was based on the relationships found in the field studies.

A different approach was taken by an ANSI standards committee (ANSI 2008). The committee used the average of the data shown in Figure A-10 (i.e., the blue dashed line) rather than the upper envelope, to predict average awakening from one event. Probability theory is then used to project the awakening from multiple noise events.

Currently, there are no established criteria for evaluating sleep disturbance from aircraft noise, although recent studies have suggested a benchmark of an outdoor SEL of 90 dB as an appropriate tentative criterion when comparing the effects of different operational alternatives. The corresponding indoor SEL would be approximately 25 dB lower (at 65 dB) with doors and windows closed, and approximately 15 dB lower (at 75 dB) with doors or windows open. According to the ANSI (2008) standard, the probability of awakening from a single aircraft event at this level is between 1 and 2% for people habituated to the noise sleeping in bedrooms with windows closed, and 2-3% with windows open. The probability of the exposed population awakening at least once from multiple aircraft events at noise levels of 90 dB SEL is shown in Table A-4.

Table A-4. Probability of Awakening from NA90SEL

Number of Aircraft Events at 90 dB SEL for Average 9-Hour Night	Minimum Probability of Awakening at Least Once	
	Windows Closed	Windows Open
1	1%	2%
3	4%	6%
5	7%	10%
9 (1 per hour)	12%	18%
18 (2 per hour)	22%	33%
27 (3 per hour)	32%	45%

Source: DOD 2009b.

In December 2008, FICAN recommended the use of this new standard. FICAN also recognized that more research is underway by various organizations, and that work may result in changes to FICAN's position. Until that time, FICAN recommends the use of the ANSI (2008) standard (FICAN 2008).

Summary

Sleep disturbance research still lacks the details to accurately estimate the population awakened for a given noise exposure. The procedure described in the ANSI (2008) Standard and endorsed by FICAN is based on probability calculations that have not yet been scientifically validated. While this procedure certainly provides a much better method for evaluating sleep awakenings from multiple aircraft noise events, the estimated probability of awakenings can only be considered approximate.

A.3.4 Noise-Induced Hearing Impairment

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

Hearing Threshold Shifts

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

TTS can result from exposure to loud noise over a given amount of time. An example of TTS might be a person attending a loud music concert. After the concert is over, there can be a threshold shift that may last several hours. While experiencing TTS, the person becomes less sensitive to low-level sounds, particularly at certain frequencies in the speech range (typically near 4,000 Hz). Normal hearing eventually returns, as long as the person has enough time to recover within a relatively quiet environment.

PTS usually results from repeated exposure to high noise levels, where the ears are not given adequate time to recover. A common example of PTS is the result of regularly working in a loud factory. A TTS can eventually become a PTS over time with repeated exposure to high noise levels. Even if the ear is given time to recover from TTS, repeated occurrence of TTS may eventually lead to permanent hearing loss. The point at which a TTS results in a PTS is difficult to identify and varies with a person's sensitivity.

Criteria for Permanent Hearing Loss

It has been well established that continuous exposure to high noise levels will damage human hearing (USEPA 1978). A large amount of data on hearing loss have been collected, largely for workers in manufacturing industries, and analyzed by the scientific/medical community. The Occupational Safety and Health Administration (OSHA) regulation of 1971 places the limit on workplace noise exposure at an average level of 90 dB over an 8-hour work period or 85 dB over a 16-hour period (U.S. Department of Labor 1971). Some hearing loss is still expected at those levels. The most protective criterion, with no measurable hearing loss after 40 years of exposure, is an average sound level of 70 dB over a 24-hour period.

The USEPA established 75 dB $L_{eq(8)}$ and 70 dB $L_{eq(24)}$ as the average noise level standard needed to protect 96% of the population from greater than a 5 dB PTS (USEPA 1978). The National Academy of Sciences Committee on Hearing, Bioacoustics, and Biomechanics (CHABA) identified 75 dB as the lowest level at which hearing loss may occur (CHABA 1977). WHO concluded that environmental and leisure-time noise below an $L_{eq(24)}$ value of 70 dB "will not cause hearing loss in the large majority of the population, even after a lifetime of exposure" (WHO 1999).

Hearing Loss and Aircraft Noise

The 1982 USEPA Guidelines report (USEPA 1982) addresses noise-induced hearing loss in terms of the "Noise-Induced Permanent Threshold Shift" (NIPTS). This defines the permanent change in hearing caused by exposure to noise. Numerically, the NIPTS is the change in threshold that can be expected from daily exposure to noise over a normal working lifetime of 40 years. A grand average of the NIPTS over time and hearing sensitivity is termed the Average NIPTS, or Ave. NIPTS for short. The Ave. NIPTS that can be expected for noise measured by the $L_{eq(24)}$ metric is given in Table A-5. Table A-5 assumes exposure to the full outdoor noise throughout the 24 hours. When inside a building, the exposure will be less (Eldred and von Gierke 1993).

The Ave. NIPTS is estimated as an average over all people exposed to the noise. The actual value of NIPTS for any given person will depend on their physical sensitivity to noise – some will experience more hearing loss than others. The USEPA Guidelines provide information on this variation in sensitivity in the form of the NIPTS exceeded by 10% of the population, which is included in the Table A-5 in the "10^{th} Percentile NIPTS" column (USEPA 1982). For individuals exposed to $L_{eq(24)}$ of 80 dB, the most sensitive of the population would be expected to show degradation to their hearing of 7 dB over time.

To put these numbers in perspective, changes in hearing level of less than 5 dB are generally not considered noticeable or significant. Furthermore, there is no known evidence that a NIPTS of 5 dB is perceptible or has any practical significance for the individual. Lastly, the variability in audiometric testing is generally assumed to be ±5 dB (USEPA 1974).

Table A-5. Ave. NIPTS and 10th Percentile NIPTS as a Function of $L_{eq(24)}$

$L_{eq(24)}$	Ave. NIPTS (dB)*	10th Percentile NIPTS (dB)*
75-76	1.0	4.0
76-77	1.0	4.5
77-78	1.6	5.0
78-79	2.0	5.5
79-80	2.5	6.0
80-81	3.0	7.0
81-82	3.5	8.0
82-83	4.0	9.0
83-84	4.5	10.0
84-85	5.5	11.0
85-86	6.0	12.0
86-87	7.0	13.5
87-88	7.5	15.0
88-89	8.5	16.5
89-90	9.5	18.0

** rounded to the nearest 0.5 dB*

Source: DOD 2012.

The scientific community has concluded that noise exposure from civil airports has little chance of causing permanent hearing loss (Newman and Beattie 1985). For military airbases, DOD policy requires that hearing risk loss be estimated for population exposed to $L_{eq(24)}$ of 80 dB or higher (DOD 2012), including residents of on-base housing. Exposure of workers inside the base boundary is assessed using DOD regulations for occupational noise exposure.

Noise in low-altitude military airspace, especially along MTRs where L_{max} can exceed 115 dB, is of concern. That is the upper limit used for occupational noise exposure (e.g., U.S. Department of Labor 1971). One laboratory study (Ising et al. 1999) concluded that events with L_{max} above 114 dB have the potential to cause hearing loss. Another laboratory study of participants exposed to levels between 115 and 130 dB (Nixon et al. 1993), however, showed conflicting results. For an exposure to four events across that range, half the subjects showed no change in hearing, a quarter showed a temporary 5 dB decrease in sensitivity, and a quarter showed a temporary 5 dB increase in sensitivity. For exposure to eight events of 130 dB, subjects showed an increase in sensitivity of up to 10 dB (Nixon et al. 1993).

Summary

Aviation noise levels are not comparable to the occupational noise levels associated with hearing loss of workers in manufacturing industries. There is little chance of hearing loss at levels less than 75 dB DNL. Noise levels equal to or greater than 75 dB DNL can occur near military airbases, and DOD policy specifies that NIPTS be evaluated when exposure exceeds 80 dB $L_{eq(24)}$ (DOD 2009c). There is some concern about L_{max} exceeding 115 dB in low altitude military airspace, but no research results to date have definitely related permanent hearing impairment to aviation noise.

A.3.5 Non-auditory Health Effects

Studies have been performed to see whether noise can cause health effects other than hearing loss. The premise is that annoyance causes stress. Prolonged stress is known to be a contributor to a number of health disorders. Cantrell (1974) confirmed that noise can provoke stress, but noted that results on cardiovascular health have been contradictory. Some studies have found a connection between aircraft noise and blood pressure (e.g., Michalak et al. 1990; Rosenlund et al. 2001), while others have not (e.g., Pulles et al. 1990).

Kryter and Poza (1980) noted, "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."

The connection from annoyance to stress to health issues requires careful experimental design. Some highly publicized reports on health effects have, in fact, been rooted in poorly done science. Meecham and Shaw (1979) apparently found a relation between noise levels and mortality rates in neighborhoods under the approach path to Los Angeles International Airport. When the same data were analyzed by others (Frerichs et al. 1980) no relationship was found. Jones and Tauscher (1978) found a high rate of birth defects for the same neighborhood. But when the Centers For Disease Control performed a more thorough study near Atlanta's Hartsfield International Airport, no relationships were found for levels above 65 dB (Edmonds et al. 1979).

A carefully designed study, Hypertension and Exposure to Noise near Airports (HYENA), was conducted around six European airports from 2002 through 2006 (Jarup et al. 2005, 2008). There were 4,861 subjects, aged between 45 and 70. Blood pressure was measured, and questionnaires administered for health, socioeconomic and lifestyle factors, including diet and physical exercise. Hypertension was defined by WHO blood pressure thresholds (WHO 2003). Noise from aircraft and highways was predicted from models.

HYENA results were presented as an odds ratio (OR). An OR of 1 means there is no added risk, while an OR of 2 would mean risk doubles. An OR of 1.14 was found for nighttime aircraft noise, measured by L_{night}, the L_{eq} for nighttime hours. For daytime aircraft noise, measured by $L_{eq(16)}$, the OR was 0.93. For road traffic noise, measured by the full day $L_{eq(24)}$, the OR was 1.1.

Note that OR is a statistical measure of change, not the actual risk. Risk itself and the measured effects were small, and not necessarily distinct from other events. Haralabidis et al. (2008) reported an increase in systolic blood pressure of 6.2 millimeters of mercury (mmHg) for aircraft noise, and an increase of 7.4 mmHg for other indoor noises such as snoring.

It is interesting that aircraft noise was a factor only at night, while traffic noise is a factor for the full day. Aircraft noise results varied among the six countries so that result is pooled across all data. Traffic noise results were consistent across the six countries.

One interesting conclusion from a 2013 study of the HYENA data (Babisch et al. 2013) states there is some indication that noise level is a stronger predictor of hypertension than annoyance. That is not consistent with the idea that annoyance is a link in the connection between noise and stress. Babisch et al. (2012) present interesting insights on the relationship of the results to various modifiers.

Two recent studies examined the correlation of aircraft noise with hospital admissions for cardiovascular disease. Hansell et al. (2013) examined neighborhoods around London's Heathrow airport. Correia et al. (2013) examined neighborhoods around 89 airports in the United States. Both studies included areas of various noise levels. They found associations that were consistent with the HYENA results. The authors of these studies noted that further research is needed to refine the associations and the causal interpretation with noise or possible alternative explanations.

Summary

The current state of scientific knowledge cannot yet support inference of a causal or consistent relationship between aircraft noise exposure and non-auditory health consequences for exposed residents. The large scale HYENA study, and the recent studies by Hansell et al. (2013) and Correia et al. (2013) offer indications, but it is not yet possible to establish a quantitative cause and effect based on the currently available scientific evidence.

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 found links between continuous high noise levels and performance loss. Noise-induced performance losses are most frequently reported in studies where noise levels are above 85 dB. Little change has been found in low-noise cases. 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 workers.

A.3.7 Noise Effects on Children

Recent studies on school children indicate a potential link between aircraft noise and both reading comprehension and learning motivation. The effects may be small but may be of particular concern for children who are already scholastically challenged.

A.3.7.1 Effects on Learning and Cognitive Abilities

Early studies in several countries (Cohen et al. 1973, 1980, 1981; Bronzaft and McCarthy 1975; Green et al. 1982; Evans et al. 1998; Haines et al. 2002; Lercher et al. 2003) showed lower reading scores for children living or attending school in noisy areas than for children away from those areas. In some studies noise exposed children were less likely to solve difficult puzzles or more likely to give up.

More recently, the Road Traffic and Aircraft Noise Exposure and Children's Cognition and Health (RANCH) study (Stansfeld et al. 2005; Clark et al. 2005) compared the effect of aircraft and road traffic noise on over 2.000 children in three countries. This was the first study to derive exposure-effect associations for a range of cognitive and health effects, and was the first to compare effects across countries.

The study found a linear relation between chronic aircraft noise exposure and impaired reading comprehension and recognition memory. No associations were found between chronic road traffic noise exposure and cognition. Conceptual recall and information recall surprisingly showed better performance in high road traffic noise areas. Neither aircraft noise nor road traffic noise affected attention or working memory (Stansfeld et al. 2005; Clark et al. 2006).

Figure A-11 shows RANCH's result relating noise to reading comprehension. It shows that reading falls below average (a z-score of 0) at L_{eq} greater than 55 dB. Because the relationship is linear, reducing exposure at any level should lead to improvements in reading comprehension.

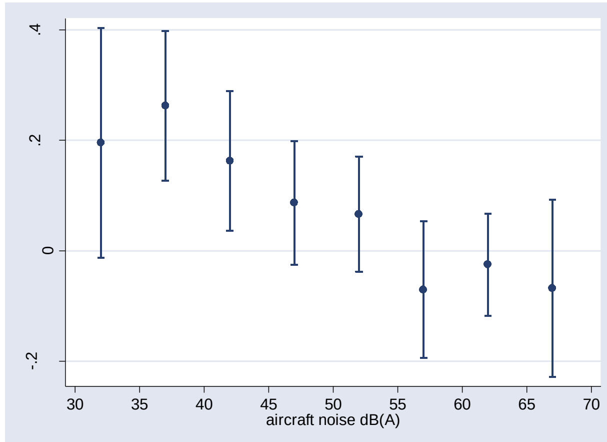


Figure A-11. RANCH Study Reading Scores Varying with L_{eq}
Sources: Stansfeld et al. 2005; Clark et al. 2006

An observation of the RANCH study was that children may be exposed to aircraft noise for many of their childhood years and the consequences of long-term noise exposure were unknown. A follow-up study of the children in the RANCH project is being analyzed to examine the long-term effects on children's reading comprehension (Clark et al. 2009). Preliminary analysis indicated a trend for reading comprehension to be poorer at 15-16 years of age for children who attended noise-exposed primary schools. There was also a trend for reading comprehension to be poorer in aircraft noise exposed secondary schools. Further analysis adjusting for confounding factors is ongoing, and is needed to confirm these initial conclusions.

FICAN funded a pilot study to assess the relationship between aircraft noise reduction and standardized test scores (Eagan et al. 2004; FICAN 2007). The study evaluated whether abrupt aircraft noise reduction within classrooms, from either airport closure or sound insulation, was associated with improvements in test scores. Data were collected in 35 public schools near three airports in Illinois and Texas. The study used several noise metrics. These were, however, all computed indoor levels, which makes it hard to compare with the outdoor levels used in most other studies.

The FICAN study found a significant association between noise reduction and a decrease in failure rates for high school students, but not middle or elementary school students. There were some weaker associations between noise reduction and an increase in failure rates for middle and elementary schools. Overall the study found that the associations observed were similar for children with or without learning difficulties, and between verbal and math/science tests. As a pilot study, it was not expected to obtain final answers, but provided useful indications (FICAN 2007).

While there are many factors that can 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 WHO and a North Atlantic Treaty Organization (NATO) 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 (NATO 2000; WHO 1999). The awareness has also led to the classroom noise standard discussed earlier (ANSI 2002).

A.3.7.2 Health Effects

A number of studies, including some of the cognitive studies discussed above, have examined the potential for effects on children's health. Health effects include annoyance, psychological health, coronary risk, stress hormones, sleep disturbance and hearing loss.

Annoyance. Chronic noise exposure causes annoyance in children (Bronzaft and McCarthy 1975; Evans et al. 1995). Annoyance among children tends to be higher than for adults, and there is little habituation

(Haines et al. 2001a). The RANCH study found annoyance may play a role in how noise affects reading comprehension (Clark et al. 2005).

Psychological Health. Lercher et al. (2002) found an association between noise and teacher ratings of psychological health, but only for children with biological risk defined by low birth weight and/or premature birth. Haines et al. (2001b) found that children exposed to aircraft noise had higher levels of psychological distress and hyperactivity. Stansfeld et al. (2009) replicated the hyperactivity result, but not distress.

As with studies of adults, the evidence suggests that chronic noise exposure is probably not associated with serious psychological illness, but there may be effects on well-being and quality of life. Further research is needed, particularly on whether hyperactive children are more susceptible to stressors such as aircraft noise.

Coronary Risk. The HYENA study discussed earlier indicated a possible relation between noise and hypertension in older adults. Cohen et al. (1980, 1981) found some increase in blood pressure among school children, but within the normal range and not indicating hypertension. Hygge et al. (2002) found mixed effects. The RANCH study found some effect for children at home and at night, but not at school. Overall the evidence for noise effects on children's blood pressure is mixed, and less certain than for older adults.

Stress Hormones. Some studies investigated hormonal levels between groups of children exposed to aircraft noise compared to those in a control group. Two studies analyzed cortisol and urinary catecholamine levels in school children as measurements of stress response to aircraft noise (Haines et al. 2001a, 2001b). In both instances, there were no differences between the aircraft-noise-exposed children and the control groups.

Sleep Disturbance. A sub-study of RANCH in a Swedish sample used sleep logs and the monitoring of rest/activity cycles to compare the effect of road traffic noise on child and parent sleep (Ohrstrom et al. 2006). An exposure-response relationship was found for sleep quality and daytime sleepiness for children. While this suggests effects of noise on children's sleep disturbance, it is difficult to generalize from one study.

Hearing loss. A few studies have examined hearing loss from exposure to aircraft noise. Noise-induced hearing loss for children who attended a school located under a flight path near a Taiwan airport was greater than for 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 greater than 75 dB DNL and L_{max} were about 87 dB during overflights. Conversely, several other studies reported no difference in hearing ability between children exposed to high levels of airport noise and children located in quieter areas (Andrus et al. 1975; Fisch 1977; Wu et al. 1995). It is not clear from those results whether children are at higher risk than adults, but the levels involved are higher than those desirable for learning and quality of life.

Ludlow and Sixsmith (1999) conducted a cross-sectional pilot study to examine the hypothesis that military jet noise exposure early in life is associated with raised hearing thresholds. The authors concluded that there were no significant differences in audiometric test results between military personnel who as children had lived in or near stations where fast jet operations were based, and a similar group who had no such exposure as children.

A.3.8 Property Values

Noise can affect the value of homes. Economic studies of property values based on selling prices and noise have been conducted to find a direct relation.

The value-noise relation is usually presented as the Noise Depreciation Index (NDI) or Noise Sensitivity Depreciation Index (NSDI), the percent loss of value per dB (measured by the DNL metric). An early study by Nelson (1978) at three airports found an NDI of 1.8-2.3% per dB. Nelson also noted a decline in NDI over time which he theorized could be due to either a change in population or the increase in commercial value of the property near airports. Crowley (1978) reached a similar conclusion. A larger study by Nelson (1980) looking at 18 airports found an NDI from 0.5 to 0.6% per dB.

In a review of property value studies, Newman and Beattie (1985) found a range of NDI from 0.2 to 2% per dB. They noted that many factors other than noise affected values.

Fidell et al. (1996) studied the influence of aircraft noise on actual sale prices of residential properties in the vicinity of a military base in Virginia and one in Arizona. They found no meaningful effect on home values. Their results may have been due to non-noise factors, especially the wide differences in homes between the two study areas.

Recent studies of noise effects on property values have recognized the need to account for non-noise factors. Nelson (2004) analyzed data from 33 airports, and discussed the need to account for those factors and the need for careful statistics. His analysis showed NDI from 0.3 to 1.5% per dB, with an average of about 0.65% per dB. Nelson (2007) and Andersson et al. (2013) discuss statistical modeling in more detail.

Enough data is available to conclude that aircraft noise has a real effect on property values. This effect falls in the range of 0.2 to 2.0% per dB, with the average on the order of 0.5% per dB. The actual value varies from location to location, and is very often small compared to non-noise factors.

A.3.9 Noise-Induced Vibration Effects on Structures and Humans

High noise levels can cause buildings to vibrate. If high enough, building components can be damaged. The most sensitive components of a building are the windows, followed by plaster walls and ceilings. Possibility of damage depends on the peak sound pressures and the resonances of the building. In general, damage is possible only for sounds lasting more than one second above an unweighted sound level of 130 dB (CHABA 1977). That is higher than expected from normal aircraft operations. Even low altitude flyovers of heavy aircraft do not reach the potential for damage (Sutherland 1990).

Noise-induced structural vibration may cause annoyance to dwelling occupants because of induced secondary vibrations, or "rattle", of objects within the dwelling – hanging pictures, dishes, plaques, and bric-a-brac. Loose window panes may also vibrate noticeably when exposed to high levels of airborne noise, causing homeowners to fear breakage. In general, rattling occurs at peak unweighted sound levels that last for several seconds at levels above 110 dB, which is well above that considered normally compatible with residential land use Thus, assessments of noise exposure levels for compatible land use will also be protective of noise-induced rattle.

The sound from an aircraft overflight travels from the exterior to the interior of the house in one of two ways: through the solid structural elements and directly through the air. Figure A-12 illustrates the sound transmission through a wall constructed with a brick exterior, stud framing, interior finish wall, and absorbent material in the cavity. The sound transmission starts with noise impinging on the wall exterior. Some of this sound energy will be reflected away and some will make the wall vibrate. The vibrating wall radiates sound into the airspace, which in turn sets the interior finish surface vibrating, with some energy lost in the airspace. This surface then radiates sound into the dwelling interior. As the figure shows, vibrational energy also bypasses the air cavity by traveling through the studs and edge connections.

Normally, the most sensitive components of a structure to airborne noise are the windows, followed by plastered walls and ceilings. An evaluation of the peak sound pressures impinging on the structure is normally sufficient to determine the possibility of damage. In general, at unweighted sound levels above 130 dB, there is the possibility of structural damage. 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 unweighted sound level of 130 dB are potentially damaging to structural components (von Gierke and Ward 1991).

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

1. Type of excitation: steady state, intermittent, or impulsive vibration.
2. Frequency of the excitation. International Organization for Standardization (ISO) standard 2631-2 (ISO 1989) recommends a frequency range of 1 to 80 Hz for the assessment of vibration on humans.
3. Orientation of the body with respect to the vibration.
4. The use of the occupied space (i.e., residential, workshop, hospital).
5. Time of day.

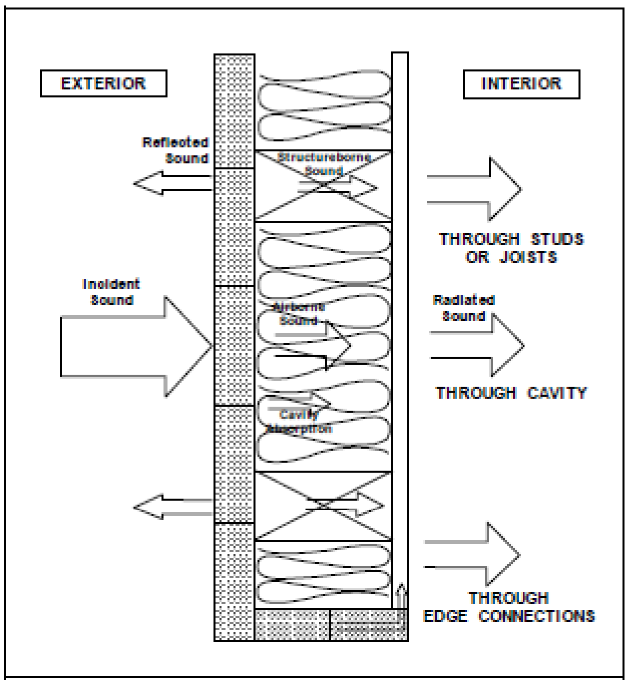


Figure A-12. Depiction of Sound Transmission through Built Construction

Table A-6 lists the whole-body vibration criteria from ISO 2631-2 for one-third octave frequency bands from 1 to 80 Hz.

Table A-6. Vibration Criteria for the Evaluation of Human Exposure to Whole-Body Vibration

	RMS Acceleration (m/s/s)		
Frequency (Hz)	Combined Criteria Base Curve	Residential Night	Residential Day
1.00	0.0036	0.0050	0.0072
1.25	0.0036	0.0050	0.0072
1.60	0.0036	0.0050	0.0072
2.00	0.0036	0.0050	0.0072
2.50	0.0037	0.0052	0.0074
3.15	0.0039	0.0054	0.0077
4.00	0.0041	0.0057	0.0081
5.00	0.0043	0.0060	0.0086
6.30	0.0046	0.0064	0.0092
8.00	0.0050	0.0070	0.0100
10.00	0.0063	0.0088	0.0126
12.50	0.0078	0.0109	0.0156
16.00	0.0100	0.0140	0.0200
20.00	0.0125	0.0175	0.0250
25.00	0.0156	0.0218	0.0312
31.50	0.0197	0.0276	0.0394
40.00	0.0250	0.0350	0.0500
50.00	0.0313	0.0438	0.0626
63.00	0.0394	0.0552	0.0788
80.00	0.0500	0.0700	0.1000

Source: ISO 1989.

A.3.10 Noise Effects on Terrain

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

A.3.11 Noise Effects on Historical and Archaeological Sites

Historical buildings and sites can have elements that are more fragile than conventional structures. Aircraft noise may affect such sites more severely than newer, modern structures. In older structures, seemingly insignificant surface cracks caused 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 measurements of noise and vibration in a restored plantation house, originally built in 1795. It is located 1,500 feet from the centerline at the departure end of Runway 19L at Washington Dulles International Airport. The aircraft measured was the Concorde. 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 (Wesler 1977).

As for conventional structures, noise exposure levels for normally compatible land uses should also be protective of historic and archaeological sites. Unique sites should, of course, be analyzed for specific exposure.

A.3.12 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 are 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 1960s and 1970s 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. 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 Manci et al. (1988) 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.3.12.1 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 summarized 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. A similar study reported abortions occurred in three out of five pregnant cattle after exposing them to flyovers by six different aircraft. Another study suggested that feedlot cattle could stampede and injure themselves when exposed to low-level overflights (U.S. Air Force 1994a).

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 1-year time period and none were associated with aircraft disturbances (U.S. Air Force 1993). In 1987, researchers contacted seven livestock operators for production data, and no effects of low-altitude and supersonic flights were noted. Of the 43 cattle previously exposed to low-altitude flights, 3 showed a startle response to an F/A-18 aircraft flying overhead at 500 feet above ground level (AGL) and 400 knots by running less than 10 meters (m). They resumed normal activity within 1 minute (U.S. Air Force 1994a). Beyer (1983) found that helicopters caused more reaction than other low-aircraft overflights, and that the helicopters at 30-60 feet overhead did not affect milk production and pregnancies of 44 cows in a 1964 study (U.S. Air Force 1994a).

Additionally, Beyer (1983) 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. 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 1994a).

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 50-100 m), as animals take care not to damage themselves (U.S. Forest Service 1992). If animals are overflown by aircraft at altitudes of 50-100 m, 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 1994a). 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 100-135 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 (Gladwin et al. 1988; Manci 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 feet) on domestic fowl, overflight activity has negligible effects (U.S. Air Force 1994b). 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 1994b). 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 1994b). 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 120-130 dB.

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. 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 1994b).

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 1994b).

A.3.12.2 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. 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).

Mammals

Terrestrial Mammals

Studies of terrestrial mammals have shown that noise levels of 120 dB can damage mammals' ears, and levels at 95 dB 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 AGL over important grizzly and polar bear habitat. Wolves have been frightened by low-altitude flights that were 25-1,000 feet AGL. 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, rising 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-kilogram 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 (Weisenberger et al. 1996).

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, are 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 dB caused a greater intensity of startle reactions than lower-intensity booms at 72-79 dB. However, the duration of the startle responses to louder sonic booms was shorter (Jehl and Cooper 1980).

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 Park 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. 1993).

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 1,000 to 5,000 Hz, 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 (Ellis et al. 1991; Grubb and King 1991). Threshold noise levels for significant responses range from 62 dB for Pacific black brant to 85 dB for crested tern (Brown 1990; Ward and Stehn 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 cooperative study between the DOD and the U.S. Fish and Wildlife Service (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 m away and SELs were 70 dB.

Lynch and Speake (1978) studied the effects of both real and simulated sonic booms on the nesting and brooding eastern wild turkey 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 10-20 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 4-8 m). Afterward, the poults resumed feeding activities while the hens remained alert for a short period of time (approximately 15-20 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.

Raptors

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

Ellis et al. (1991), performed a study to estimate the effects of low-level military jet aircraft and mid- to high-altitude sonic booms (both actual and simulated) on nesting peregrine falcons and seven other raptors (common black-hawk, Harris' hawk, zone-tailed hawk, red-tailed hawk, golden eagle, prairie falcon, bald eagle). They observed responses to test stimuli, determined nest success for the year of the testing, and evaluated site occupancy the following year. Both long- and short-term effects were noted in the study. The results reported the successful fledging of young in 34 of 38 nest sites (all eight species) subjected to low-level flight and/or simulated sonic booms. Twenty-two of the test sites were revisited in the following year, and observations of pairs or lone birds were made at all but one nest. Nesting attempts were underway at 19 of 20 sites that were observed long enough to be certain of breeding activity. Reoccupancy and productivity rates were within or above expected values for self-sustaining populations.

Short-term behavior responses were also noted. Overflights at a distance of 150 m or less produced few significant responses and no severe responses. Typical responses consisted of crouching or, very rarely, flushing from the perch site. Significant responses were most evident before egg laying and after young were "well grown." Incubating or brooding adults never burst from the nest, thus preventing egg breaking or knocking chicks out of the nest. Jet passes and sonic booms often caused noticeable alarm; however, significant negative responses were rare and did not appear to limit productivity or re-occupancy. 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 (Ellis et al. 1991).

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 dB) 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 m 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 m, 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 (USFWS 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 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 (9 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.

Migratory Waterfowl

Fleming et al. (1996) conducted a study of caged American black ducks found 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 (Fleming et al. 1996).

Another study by Conomy et al. (1998) exposed previously unexposed ducks to 71 noise events per day that equaled or exceeded 80 dB. It was determined that the proportion of time black ducks reacted to aircraft activity and noise decreased from 38% to 6% in 17 days and remained stable at 5.8% 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 less than 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).

Wading and Shorebirds

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 dB 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. Approximately 90% displayed no reaction or merely looked toward the direction of the noise source. Another 6% stood up, 3% walked from the nest, and 2% 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 85-100 dB on approach and 94-105 dB on takeoff. Generally, there did not appear to be any prominent adverse effects of subsonic aircraft on nesting, although some birds flushed when the Concorde flew overhead and, when they returned, engaged in aggressive behavior. Groups of gulls tended to loaf in the area of the nesting colony, and these birds remained at the roost when the Concorde flew overhead. Up to 208 of the loafing gulls flew when supersonic aircraft flew overhead. These birds would circle around and immediately land in the loafing flock (U.S. Air Force 2000).

In 1970, sonic booms were potentially linked to a mass hatch failure of sooty terns on the Dry Tortugas (Austin et al. 1970). The cause of the failure was not certain, but it was conjectured that sonic booms from military aircraft or an overgrowth of vegetation were factors. In the previous season, sooty terns 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 tern hatch failure.

Subsequent laboratory tests of exposure of eggs to sonic booms and other impulsive noises (Cottereau 1972; Cogger and Zegarra 1980; Bowles et al. 1991, 1994) failed to show adverse effects on hatching of eggs. A structural analysis by 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.

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 spadefoot toads, 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 a DNL of 85 dB.

A.3.12.3 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.

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APPENDIX B

OPNAVINST 11010.36C
LAND USE COMPATIBILITY TABLES

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Table 1 Air Installations Compatible Use Zones Suggested Land Use Compatibility in Noise Zones

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

Table 1 Air Installations Compatible Use Zones Suggested Land Use Compatibility in Noise Zones

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

Table 1 Air Installations Compatible Use Zones Suggested Land Use Compatibility in Noise Zones

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

Table 1 Air Installations Compatible Use Zones Suggested Land Use Compatibility in Noise Zones

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

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

Key to Table 1:

SLUCM = Standard Land Use Coding Manual, U.S. Department of Transportation
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 note(s) indicated by the superscript.
N^x (No with exceptions) = The land use and related structures are generally incompatible. However, see notes indicated by the superscript.
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.
25, 30, or 35 = The numbers refer to NLR levels. Land use and related structures generally compatible however, measures to achieve NLR of 25, 30, or 35 must be incorporated into design and construction of structures. However, measures to achieve an overall noise reduction do not necessarily solve noise difficulties outside the structure and additional evaluation is warranted. Also, see notes indicated by superscripts where they appear with one of these numbers.
DNL = Day Night Average Sound Level.
CNEL = Community Noise Equivalent Level (normally within a very small decibel difference of DNL)
Ldn = Mathematical symbol for DNL.

Notes for Table 1:

1. General:
   a. Although local conditions regarding the need for housing may require residential use in these zones, residential use is discouraged in DNL 65 to 69 and strongly discouraged in DNL 70 to 74. The absence of viable alternative development options should be determined and an evaluation should be conducted locally prior to local 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 these uses must be allowed, measures to achieve an outdoor to indoor NLR of at least 25 decibels (dB) in DNL 65 to 69 and NLR of 30 dB in DNL 70 to 74 should be incorporated into building codes and be in individual approvals; for transient housing a NLR of at least 35 dB should be incorporated in DNL 75 to 79.
   c. Normal permanent construction can be expected to provide a 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 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 noise exposure particularly from ground level sources. Measures that reduce noise at a site should be used wherever practical in preference to measures that only protect interior spaces.
2. Measures to achieve 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.
3. Measures to achieve 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

Table 1 Air Installations Compatible Use Zones Suggested Land Use Compatibility in Noise Zones

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

normal noise level is low.

4. Measures to achieve 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.
5. If project or proposed development is noise sensitive, use indicated NLR; if not, land use is compatible without NLR.
6. No buildings.
7. Land use compatible provided special sound reinforcement systems are installed.
8. Residential buildings require a NLR of 25.
9. Residential buildings require a NLR of 30.
10. Residential buildings not permitted.
11. Land use not recommended, but if community decides use is necessary, hearing protection devices should be worn.

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

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

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

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

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

SLUCM No.	Land Use Name	CLEAR ZONE Recommendation	APZ I Recommendation	APZ II Recommendation	Density Recommendation
56	Retail trade – apparel and accessories	N	N	Y	Max FAR of 0.28 in APZ II
57	Retail trade – furniture, home furnishings and equipment	N	N	Y	Same as above
58	Retail trade – eating and drinking establishments	N	N	N	
59	Other retail trade	N	N	Y	Max FAR of 0.16 in APZ II
60	**Services[8]**				
61	Finance, insurance and real estate services	N	N	Y	Max FAR of 0.22 for "General Office/ Office Park" in APZ II
62	Personal services	N	N	Y	Office uses only. Max FAR of 0.22 in APZ II.
62.4	Cemeteries	N	Y[9]	Y[9]	
63	Business services (credit reporting; mail, stenographic reproduction; advertising)	N	N	Y	Max FAR of 0.22 in APZ II
63.7	Warehousing and storage services	N	Y	Y	Max FAR of 1.0 in APZ I; 2.0 in APZ II
64	Repair services	N	Y	Y	Max FAR of 0.11 in APZ I; 0.22 in APZ II
65	Professional services	N	N	Y	Max FAR of 0.22 in APZ II
65.1	Hospitals, nursing homes	N	N	N	
65.1	Other medical facilities	N	N	N	
66	Contract construction services	N	Y	Y	Max FAR of 0.11 in APZ I; 0.22 in APZ II
67	Governmental services	N	N	Y	Max FAR of 0.24 in APZ II
68	Educational services	N	N	N	
69	Miscellaneous	N	N	Y	Max FAR of 0.22 in APZ II
70	**Cultural, entertainment and recreational**				
71	Cultural activities	N	N	N	
71.2	Nature exhibits	N	Y[10]	Y[10]	
72	Public assembly	N	N	N	
72.1	Auditoriums, concert halls	N	N	N	
72.11	Outdoor music shells, amphitheaters	N	N	N	

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

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

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

Key to Table 2:

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

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

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

Notes for Table 2:

1. A "Yes" or a "No" designation for compatible land use is to be used only for general comparison. Within each, uses exist where further evaluation may be needed in each category as to whether it is clearly compatible, normally compatible, or not compatible due to the variation of densities of people and structures. In order to assist installations and local governments, general suggestions as to FARs are provided as a guide to densities in some categories. In general, land-use restrictions which limit commercial, services, or industrial buildings or structure occupants to 25 per acre in APZ I and 50 per acre in APZ II are the range of occupancy levels, including employees, considered to be low density. Outside events should normally be limited to assemblies of not more than 25 people per acre in APZ I, and Maximum (Max) assemblies of 50 people per acre in APZ II.
2. The suggested maximum density for detached single-family housing is one to two Du/Ac. In a Planned Unit Development (PUD) of single-family detached units where clustered housing development results in large open areas, this density could possibly be increased provided the amount of surface area covered by structures does not exceed 20 percent of the PUD total area. PUD encourages clustered development that leaves large open areas.
3. Other factors to be considered: labor intensity, structural coverage, explosive characteristics, air pollution, electronic interference with aircraft, height of structures, and potential glare to pilots.
4. No structures (except airfield lighting), buildings or aboveground utility/communications lines should normally be located in clear zone areas on or off the installation. The clear zone is subject to severe restrictions. See UFC 3-260-01, "Airfield and Heliport Planning and Design" dated 10 November 2001 for specific design details.
5. No passenger terminals and no major aboveground transmission lines in APZ I.
6. Within SLUCM Code 52, Max FARs for lumber yards (SLUCM Code 521) are 0.20 in APZ I and 0.40 in APZ II. For hardware/paint and farm equipment stores, SLUCM Code 525, the Max FARs are 0.12 in APZ I and 0.24 in APZ II.
7. A shopping center is an integrated group of commercial establishments that is planned, developed, owned, or managed as a unit. Shopping center types include strip, neighborhood, community, regional, and super regional facilities anchored by small businesses, supermarket or drug store, discount retailer, department store, or several department stores, respectively. Included in this category are such uses as big box discount clubs, home improvement superstores, office supply superstores, and electronics superstores. The Max recommended FAR for SLUCM 53 should be applied to the gross leasable area of the shopping center rather than attempting to use other recommended FARs listed in Table 2 under "Retail" or "Trade."
8. Low intensity office uses only. Accessory use such as meeting places, auditoriums, etc., are not recommended.
9. No chapels are allowed within APZ I or APZ II.
10. Facilities must be low intensity and provide no tot lots, etc. Facilities such as clubhouses, meeting places, auditoriums, large classes, etc., are not recommended.
11. Includes livestock grazing but excludes feedlots and intensive animal husbandry. Activities that attract concentrations of birds creating a hazard to aircraft operations should be excluded.
12. Includes feedlots and intensive animal husbandry.
13. Lumber and timber products removed due to establishment, expansion, or maintenance of clear zones will be disposed of in accordance with appropriate DoD Natural Resources instructions.
14. Controlled hunting and fishing may be permitted for the purpose of wildlife management.
15. Naturally occurring water features (e.g., rivers, lakes, streams, wetlands) are compatible.