

# **Pennsylvania Army National Guard INSTALLATION COMPATIBLE USE ZONE STUDY**



**December 2018**



**Environmental Noise Branch  
Army Public Health Center**

# **Pennsylvania Army National Guard**

## **ICUZ**

### **INSTALLATION COMPATIBLE USE ZONE**

## **STUDY**

December 2018



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# EXECUTIVE SUMMARY

## OVERVIEW

One of the goals of the Department of the Army is to plan, initiate, and carry out actions and programs designed to minimize adverse impacts upon the quality of the human environment without impairing the Army's mission. The Installation Compatible Use Zone (ICUZ) Program implements Army policy for such planning. The ICUZ study quantifies the noise environment from military training sources and recommends the most appropriate uses of noise-impacted areas. This study replaces the June 2012 Statewide Operational Noise Management Plan and provides information that reflects the most recent account of activities as of 2018.

Army Regulation (AR) 200-1 lists housing, schools, and medical facilities as examples of noise-sensitive land uses. Regulation guidelines state for land use planning purposes, noise-sensitive land uses are acceptable within the Noise Zone I, generally not compatible in Noise Zone II, and incompatible in Noise Zone III. AR 200-1 offers land use recommendations, which if adopted both on and off the installation, would facilitate future development that is unaffected by military noise. These guidelines are applied throughout the ICUZ document as individual training operations are analyzed.

The principle Pennsylvania Army National Guard (PAARNG) training facilities which generate noise are the Fort Indiantown Gap (FTIG) Training Center, which includes the Muir Army Airfield and the Eastern Army National Guard Aviation Training Site, and the Army Aviation Support Facility (AASF) #2 located at the Johnstown-Cambria County Airport.

## CONCLUSIONS

### **FTIG SMALL ARMS WEAPONS NOISE**

#### Small Arms Ranges

Small arms operations at FTIG take place at both dedicated small arms ranges at the non-duded impact area in the eastern portion of FTIG, and within the larger multi-purpose training complexes in the main training corridor. Small arms firing activities at these ranges occur frequently throughout the year. Multiple ranges concurrently firing can be a common daily occurrence in the busiest months of the year.

The Noise Zones from small arms firing are generally contained to training lands on post; however, Zone II does extend off post in several areas, most prominently along the western boundary. Zone III also extends just beyond the west boundary. The terrain features along the north and south boundary of the training corridor provide significant attenuation of sound from live-fire activities in this area. Land use within Zone II off post is primarily forest land, with some pasture and agricultural lands. Single-family residences are contained within the Zone II areas east and south of the boundary, with the largest concentration of residential land use occurring west of FTIG. The

areas north are uninhabited State Game Lands. Zone III beyond the west boundary does not contain any noise-sensitive land use.

On post, Zone II and Zone III extend into the cantonment area from firing at the range complex, encompassing enlisted barracks buildings and family housing structures on the west end of the cantonment. Zone III does not contain any noise-sensitive land uses.

#### Non-Fixed Firing Ranges

Training activities which require the firing of small arms weapons using blank ammunition occur in multiple collective training facilities in the central portion of the Fort. Maneuver training areas also support these operations at FTIG. In most cases, weapons fire takes place far enough from the installation boundary that noise impacts would be minimal.

### **FTIG LARGE CALIBER WEAPONS AND EXPLOSIVES NOISE**

#### Land Use Compatibility

The cumulative large caliber and demolition operations Noise Zones show impacts to sensitive land uses are generally limited to the areas northeast and west of the installation boundary. As was the case with small arms firing, the mountain ranges along the north and south boundary of FTIG provide significant attenuation of large caliber noise. Land use within the Zone II off post is primarily forest and agricultural lands, with some low-density residential. There are no noise-sensitive land uses contained within Zone III.

The largest number of sensitive land uses occurs within the Land Use Planning Zone (LUPZ), which extends into the Valley east and west, and just along the south boundary. Noise-sensitive land use within the LUPZ is considered compatible per Army guidelines; however, the LUPZ is delineated to indicate areas of emphasis for land use planners. These areas, although below Zone II limits, represent noise levels that some communities may still find unacceptable.

On post, the Noise Zones extend south into a localized area of the cantonment area. Zone II contains several enlisted barracks and family housing adjacent to the airfield, as well as several homes located inside the inholdings on the east end of the training corridor. Zone III does not contain any sensitive land use.

#### Single Event Levels

Peak levels correlate with the receiver's perception of noise levels and can be a good predictor of complaints. Peak sound levels are included in this study as a supplement to land use compatibility Noise Zones. People in an area experiencing peak sound pressure levels between 115 and 130 dB may describe events as noticeable and distinct. Peak sound pressure levels above 130 dB are generally objectionable, and are often described as very loud and startling. Peak levels can vary significantly for the same activity based upon weather conditions. Peak sound levels in this study were modeled with two meteorological conditions (unfavorable and neutral weather) applied.

Under unfavorable weather, peak sound levels between 115 and 130 dB extend beyond the boundary in all directions, but to the greatest degree east and west. Residential land use in these

areas is common. The 115-130 dB noise contour also extends south of the cantonment as far as Interstate 81. The land in this area is comprised primarily of Fort Indiantown Gap National Cemetery.

Peak sound levels above 130 dB extend beyond the boundary northeast, west, and one area south. There are no sensitive land uses contained within these areas. However, there are multiple single family homes just beyond the contour northeast and along the southwest boundary. Thus, during weather that favors propagation, these homes may receive a greater-than-normal noise dose from large caliber weapons training.

On post, peak sound levels between 115 and 130 dB envelope the majority of the cantonment, along with Memorial Lake State Park, and homes within the inholding area north of the state park. Peak sound levels above 130 dB within the cantonment contain multiple troop barracks and family housing buildings. In addition, two inholding areas containing several occupied homes are contained within the 130 dB contour in the east end of the main training corridor.

Under neutral weather conditions, peak sound levels diminish considerably, particularly along the eastern and southern boundaries. Noise impacts to sensitive land use are generally limited to the area southwest, where scattered residential properties exist. Peak sound levels above 130 dB extend beyond the installation boundary in one small area northeast, and one area south. There are no sensitive land uses contained in either of these areas.

On post, sound levels between 115 and 130 dB once again extend south into the cantonment, encompassing troop barracks and some family housing structures. Inholding areas on the east end of the main training corridor are in the 115-130 dB contour. Peak sound levels above 130 dB in the cantonment are primarily confined to the airfield which does not contain any sensitive land use.

## **FTIG AVIATION NOISE**

### Muir Army Airfield – AASF #1

The Noise Zones from operations at Muir Army Airfield show the greatest impacts to sensitive land use off post are east of the installation. Zone II extends beyond the boundary east and south of the main cantonment. Land use is a mix of agricultural, forest, commercial, and residential. Land use in the area south is primarily national cemetery lands. Zone III does not extend beyond the FTIG boundary.

On post, the Noise Zones encompass the majority of the cantonment area. Sensitive land use within Zone II is generally troop barracks and family housing facilities. Zone III extending west primarily contains compatible land use, with the exception of several non-military housing structures on Clement Avenue.

### Unmanned Aerial Systems

Unmanned Aerial System (UAS) launch and recovery operations take place at FTIG using the RQ-7 Shadow UAS aircraft. Training flight missions take place within the restricted airspace

R-5802 at FTIG. Generally, the noise produced from UAS activities within the shared airspace is considerably quieter than other larger aircraft activities. Once UAS aircraft reach mission altitudes the annoyance potential from overflight is low.

#### Aircraft Single Overflight

Aircraft operating outside of the airfield within a designated low-level flight track, aviation training area, maintenance test flight area, or transitioning within the local flying area all have the potential to cause annoyance and possibly generate noise complaints from single overflight. This also includes fixed-wing aircraft making use of the Bollen Air-to-Ground Range and Drop Zones at FTIG. Noise abatement measures are currently in place to help mitigate the effects of aircraft noise, including minimum flight altitudes and procedures to avoid residential overflight.

### **ARMY AVIAATION SUPPORT FACILITY #2**

#### AASF #2 – Johnstown-Cambria County Airport

Annual rotary-wing operations at the AASF #2, although steady, are not high enough to generate a Zone II or Zone III which extends beyond the airport boundary. In addition, the AASF is collocated at a joint military and civilian airport, where several other noise-producing aircraft, including military rotary-wing and civilian fixed-wing general aviation operations take place daily. Nevertheless, individual flights departing and arriving at the support facility or operating within the local flying area have the potential to cause annoyance and produce noise complaints.

### **RECOMMENDATIONS**

The ICUZ is a proactive planning tool, which can help guide future development in surrounding communities. At a minimum, local municipal governments are encouraged to support public disclosure of all Noise Zones and supplemental metrics which may convey how military training operations affect the noise environment.

The ICUZ study describes the noise characteristics of a specific operational environment, and as such, will change if a significant operational change is made. Therefore, if the PAARNG mission, training, or training facilities undergo changes, the ICUZ should be reviewed to determine if the current noise assessment is sufficient. At a minimum, it is recommended that every five years the ICUZ and/or Noise Zones be updated to incorporate pertinent changes to the noise environment.

**SECTION**

1 INTRODUCTION ..... 1-1

    1.1 GENERAL..... 1-1

    1.2 PURPOSE AND NEED..... 1-1

    1.3 PROCESS AND PROCEDURE..... 1-2

        1.3.1 REGULATORY REQUIREMENTS..... 1-2

        1.3.2 NOISE EXPOSURE MODELS..... 1-2

    1.4 NOISE BASICS ..... 1-3

        1.4.1 NOISE METRICS ..... 1-3

        1.4.2 SOUND PROPAGATION..... 1-4

2 PENNSYLVANIA ARMY NATIONAL GUARD..... 2-1

    2.1 GENERAL..... 2-1

    2.2 MISSION AND ORGANIZATION..... 2-1

    2.3 PENNSYLVANIA NATIONAL GUARD ECONOMIC IMPACT ..... 2-3

    2.4 NOISE MANAGEMENT PROGRAM ..... 2-4

        2.4.1 NOISE COMPLAINT MANAGEMENT..... 2-4

3 NOISE ASSESSMENT GUIDELINES ..... 3-1

4 FORT INDIANTOWN GAP ..... 4-1

    4.1 LOCATION ..... 4-1

    4.2 LOCAL COMMUNITIES ..... 4-1

    4.3 RANGES AND TRAINING..... 4-4

    4.4 RANGE NOISE ASSESSMENT ..... 4-7

        4.4.1 SMALL ARMS NOISE..... 4-7

        4.4.2 SMALL ARMS NOISE ZONES ..... 4-7

        4.4.3 NON-FIXED FIRING SMALL ARMS AREAS ..... 4-11

        4.4.4 LARGE CALIBER AND DEMOLITION NOISE..... 4-12

        4.4.5 LARGE CALIBER AND DEMOLITION NOISE ZONES..... 4-12

        4.4.6 LARGE CALIBER AND DEMOLITION SINGLE EVENT PEAK LEVELS.... 4-17

    4.5 SIMULATOR NOISE ..... 4-20

    4.6 AIRCRAFT NOISE..... 4-21

        4.6.1 MUIR ARMY AIRFIELD..... 4-23

            4.6.1.1 MUIR ARMY AIRFIELD NOISE ZONES ..... 4-23

        4.6.2 ANNOYANCE POTENTIAL FROM SINGULAR OVERFLIGHT..... 4-25

4.6.3	BOLLEN AIR-TO-GROUND RANGE .....	4-30
4.6.4	UNMANNED AERIAL SYSTEM AIRCRAFT .....	4-31
5	ARMY AVIATION SUPPORT FACILITY # 2 - JOHNSTOWN .....	5-1
5.1	GENERAL .....	5-1
5.2	AIRCRAFT NOISE .....	5-1
5.3	ANNOYANCE POTENTIAL FROM SINGLE OVERFLIGHT .....	5-1
6	NOISE RELATED LAND USE POLICY AND CONTROL .....	6-1
6.1	INTRODUCTION .....	6-1
6.2	ACHIEVING LAND USE COMPATIBILITY .....	6-1
6.3	JOINT LAND USE STUDY (JLUS).....	6-1
6.4	ARMY COMPATIBLE USE BUFFER (ACUB) PROGRAM.....	6-3
6.5	LAND USE PLANNING OPTIONS .....	6-5
7	SUMMARY .....	7-1
7.1	FTIG SMALL ARMS WEAPONS .....	7-1
7.2	FTIG LARGE CALIBER WEAPONS AND EXPLOSIVES .....	7-1
7.3	FTIG AVIATION ACTIVITY .....	7-2
7.4	ARMY AVIATION SUPPORT FACILITY #2 .....	7-3
7.5	RECOMMENDATIONS .....	7-3
A	GLOSSARY OF TERMS .....	A-1
B	LAND USE GUIDELINES .....	B-1
C	DATA USED TO GENERATE NOISE ZONES .....	C-1
D	REFERENCES.....	D-1

**FIGURES**

Figure 1-1.	Example of a Temperature Inversion .....	1-5
Figure 2-1.	PAARNG Facility General Locations.....	2-2
Figure 4-1.	FTIG General Location .....	4-2
Figure 4-2.	Local Townships Surrounding FTIG .....	4-3
Figure 4-3.	FTIG Range and Training Area Locations.....	4-6
Figure 4-4.	FTIG Small Arms Noise Zones.....	4-8
Figure 4-5.	FTIG Small Arms Noise Zones Extending West.....	4-10
Figure 4-6.	FTIG Large Caliber and Demolition Operations CDNL Noise Zones .....	4-13
Figure 4-7.	FTIG CDNL Noise Zones Extending West .....	4-15
Figure 4-8.	FTIG CDNL Noise Zones Extending East.....	4-16
Figure 4-9.	Large Caliber and Demolition Operations PK15(met) Sound Levels .....	4-18
Figure 4-10.	Large Caliber and Demolition Operations PK50(met) Sound Levels .....	4-19
Figure 4-11.	FTIG Airspace and Aviation Operation Areas.....	4-22



Figure 4-12. Muir Army Airfield ADNL Noise Zones..... 4-24  
 Figure 5-1. AASF #2 – Johnstown-Cambria County Airport General Location..... 5-2  
 Figure 6-1. FTIG ACUB Priority Areas ..... 6-4

**TABLES**

Table 1-1. University of Utah Criteria for "Good" and "Bad" Firing Conditions ..... 1-6  
 Table 2-1. Economic Impact (FY 2016)..... 2-3  
 Table 3-1. Noise Limits for Noise Zones..... 3-1  
 Table 3-2. Complaint Risk Guidelines..... 3-1  
 Table 4-1. Regional Population Summary Surrounding FTIG..... 4-1  
 Table 4-2. Small Arms Ranges ..... 4-4  
 Table 4-3. Large Caliber Training Ranges / Facilities..... 4-5  
 Table 4-4. Collective Training Facilities ..... 4-5  
 Table 4-5. Small Arms Noise Zones Acreage ..... 4-9  
 Table 4-6. Population Exposure in Small Arms Noise Zones ..... 4-9  
 Table 4-7. Predicted Peak Levels for 5.56 mm Blank Round ..... 4-11  
 Table 4-8. Predicted Peak for 7.62 mm Blank Round ..... 4-11  
 Table 4-9. Large Caliber and Demolition Noise Zones Acreage..... 4-14  
 Table 4-10. Population Exposure in Large Caliber and Demolition Noise Zones ..... 4-14  
 Table 4-11. Predicted Peak Noise Levels for Typical Army Simulators..... 4-20  
 Table 4-12. Muir AAF Noise Zones Acreage..... 4-23  
 Table 4-13. Population Exposure in Muir AAF Noise Zones ..... 4-25  
 Table 4-14. Maximum A-Weighted Sound Levels for Rotary-Wing Aircraft ..... 4-26  
 Table 4-15. Maximum A-Weighted Sound Levels for Fixed-Wing Aircraft ..... 4-26  
 Table 4-16. Percentage of Population Highly Annoyed from Aircraft Noise ..... 4-26  
 Table 4-17. Rotary-Wing Overflight Annoyance Potential<sup>1</sup>..... 4-28  
 Table 4-18. Fixed-Wing Overflight Annoyance Potential<sup>1</sup> ..... 4-29  
 Table 4-19. Maximum A-Weighted Sound Levels for Jet Fighter Aircraft ..... 4-30

**ACRONYMS AND ABBREVIATIONS**

AAD	Average Annual Day
AASF	Army Aviation Support Facility
AAF	Army Airfield
ACUB	Army Compatible Use Buffer
ADNL	A-Weighted Day-Night Average Sound Level
AGL	Above Ground Level
APHC	Army Public Health Center
AR	Army Regulation
CACTF	Combined Arms Collective Training Facility
CDNL	C-Weighted Day-Night Average Sound Level
CY	Calendar Year
dB	Decibel(s)
dBA	Decibels, A-Weighted
dBc	Decibels, C-Weighted
dBp	Decibels, Unweighted Peak
DEM	Digital Elevation Model
DNL	Day-Night Average Sound Level
DoD	Department of Defense
DODI	Department of Defense Instruction
DZ	Drop Zone
EAATS	Eastern Army National Guard Aviation Training Site
ECAB	Expeditionary Combat Aviation Brigade
ERG	Explosives Research Group
FAA	Federal Aviation Administration
FICUN	Federal Interagency Committee on Urban Noise
FTIG	Fort Indiantown Gap
FY	Fiscal Year
GIS	Geographic Information Systems
HE	High Explosive
ICUZ	Installation Compatible Use Zone
ID	Infantry Division
IED	Improvised Explosive Device
JLUS	Joint Land Use Study
JTAC	Joint Terminal Attack Controller
KD	Known Distance
KM	Kilometer
LEQ	Equivalent Sound Level
LFA	Local Flying Area
LUPZ	Land Use Planning Zone
M	Meter
MCA	Military Compatibility Area
MOU	Military Operations in Urban Terrain
MPMG	Multi-Purpose Machine Gun

MPTR	Multi-Purpose Training Range
MSL	Mean Sea Level
MTF	Maintenance Test Flight
NLR	Noise Level Reduction
NOE	Nap of the Earth
NTA	Northern Training Area
OEA	Office of Economic Adjustment
PAANG	Pennsylvania Air National Guard
PAARNG	Pennsylvania Army National Guard
PAO	Public Affairs Office
SARNAM	Small Arms Range Noise Assessment Model
SEL	Sound Exposure Level
SGL	State Game Land
TA	Training Area
UAC	Urban Assault Course
UAS	Unmanned Aerial System

# 1 INTRODUCTION

## 1.1 GENERAL

The Installation Compatible Use Zone (ICUZ) study provides a strategy for noise management in the areas surrounding Pennsylvania Army National Guard (PAARNG) training facilities, mainly Fort Indiantown Gap (FTIG) and the Army Aviation Support Facility (AASF) #2 (Johnstown-Cambria County Airport). Elements of the ICUZ program include military noise analysis, education about noise and Army noise metrics, complaint management, and when necessary, noise abatement procedures.

The report is provided to assist both PAARNG personnel and local community officials. Specifically, the ICUZ provides a methodology for analyzing noise exposure associated with military operations and provides land use guidelines for achieving compatibility between the noise generated by the Army and the surrounding communities.

As local communities prepare and modify comprehensive development plans, it is recommended that the conclusions from this study be considered in the planning process with a goal to encourage compatible land use.

## 1.2 PURPOSE AND NEED

The Army has an obligation to U.S. citizens to recommend land use around its installations which will: (a) protect citizens from noise and other hazards; and (b) protect the public's investment in these training facilities. To meet these obligations, the Army will recommend land uses that are compatible with military operations while allowing maximum beneficial use of adjacent properties. The U.S. Department of Defense (DoD) and component Services have published guidelines that reflect these land use recommendations.

Through Army Regulation (AR) 200-1, noise exposure on communities is translated into Noise Zones. Regulation guidelines state that for land use planning purposes, noise-sensitive land uses range from acceptable to not compatible within the Noise Zones. These guidelines are applied throughout the ICUZ as individual or combined training operations are analyzed. The program defines the following four Noise Zones:

- Zone III - Noise-sensitive land uses are not recommended (incompatible).
- Zone II - Although local conditions such as availability of developable land or cost may require noise-sensitive land uses in Zone II, this type of land use is generally not compatible and is strongly discouraged on the installation and in surrounding communities. All viable alternatives should be considered to limit development in Zone II to non-sensitive activities such as industry, manufacturing, transportation and agriculture.
- Zone I - Noise-sensitive land uses are acceptable within the Zone I. However, though an area may only receive Zone I levels, military operations may be loud enough to be heard -

or even judged loud on occasion. Zone I is not one of the contours shown on the map; rather it is the entire area outside of the Zone II contour.

- The Land Use Planning Zone (LUPZ) is a subdivision or upper limit of Zone I. The LUPZ represents an area starting at the lower limit of Zone II and extends outward to a distance significant enough to allow for a 5 decibel (dB) reduction in sound level for large caliber and aircraft noise (There is no LUPZ for small arms activity Noise Zones). Within this area, noise-sensitive land uses are generally acceptable. However, communities and individuals often have different views regarding what level of noise is acceptable or desirable. To address this, some local governments have implemented land use planning measures out beyond the Zone II limits. Additionally, implementing planning controls within the LUPZ can develop a buffer to avert future noise conflicts.

The need for noise compatibility assessments in the Army is a greater challenge today than at any point in the past. Rapid population growth has brought land development directly adjacent to many Army installations, which were at one point relatively remote locations. This development, often referred to as encroachment, has brought military installations and civilian communities in much closer proximity, leading to issues of incompatibility.

To prevent incompatibilities between military operations and civilian land use from reaching a significant level, the Army must take reasonable steps to protect the community from military training noise, and it must work with local governments and land owners to make sure that adjoining lands are developed in ways compatible with the noise environment. Of particular concern are areas within the aforementioned Noise Zones, as well as areas that may occasionally be subjected to noise levels that the local community may find objectionable.

### **1.3 PROCESS AND PROCEDURE**

#### **1.3.1 REGULATORY REQUIREMENTS**

This assessment has been conducted in accordance with the DoD Instruction Directive 4715.13 *subject: DoD Noise Program* (DoD 2005) and Army Regulation (AR) 200-1, *Environmental Protection and Enhancement*, Chapter 14, *Operational Noise* (U.S. Army 2007).

#### **1.3.2 NOISE EXPOSURE MODELS**

Operational data includes the types of weapons and ammunitions fired, number of rounds fired, time of day in which rounds are fired, and the location of firing areas and targets. The data were input into computer software models which calculate noise exposure levels associated with the multiple types of military operations ongoing at FTIG and aviation facilities. A summary of the computer models is provided below:

- The computer model used to create the Noise Zones for small arms (.50 caliber and below) ranges is the Small Arms Range Noise Assessment Model (SARNAM). SARNAM incorporates information on weapons noise source models, directivity, sound propagation, and the effects of noise mitigation and safety structures when necessary. The SARNAM calculation algorithms assume weather conditions or wind direction that favors sound

propagation. Small caliber weapons noise is addressed utilizing Peak sound levels and therefore has no assessment period.

- The BNOISE2 modeling program calculates noise levels generated by firing large caliber weapons (20mm and greater) and high-explosive charges. The sounds from large arms, demolitions, and other impulsive sounds generally create the largest complaint issues because the sound can travel far, is difficult to mitigate and can be accompanied by vibration that may increase the public's annoyance. Noise Zones for large caliber weapons are addressed using the C-weighted Day-Night average sound Level (CDNL).
- NOISEMAP is a suite of computer programs and components developed by the Air Force to predict noise exposure in the vicinity of an airfield due to aircraft flight, maintenance, and ground run-up operations. Aircraft flight data are obtained to derive average daily operations by runway and type of aircraft. Noise Zones for aircraft operations are addressed using the A-weighted Day-Night average sound Level (ADNL).

## 1.4 NOISE BASICS

Sound is defined as a physical disturbance in a medium (i.e. gas, liquid, or solid) that is capable of being detected by the human ear. Sound waves in air are caused by variations in pressure above and below an even (static) value in atmospheric pressure. These changes in atmospheric pressure as they relate to human hearing can have great variance, for example a whisper at two meters would be as low as 0.0006 Pascals, whereas an M16 rifle fired near the shooter's ear would be 1,000 Pascals.

Due to this large range of sound pressures and that the human ear responds more closely to a logarithmic scale (rather than a linear), the decibel (dB) system was developed to quantify sound energy (loudness) into a meaningful and manageable scale. On this scale, the range of average human hearing runs from approximately zero (threshold of hearing) to 140. Using the example above, the whisper at two meters would register 30 dB and the M16 rifle shot near the shooter's ear would be 154 dB.

### 1.4.1 NOISE METRICS

When measuring sound, the levels are often filtered (i.e. frequency weighted) to accommodate how the human ear functions. This process is known as "A-weighting" and can be assumed for all sound levels in this report unless otherwise specified. Military impulsive sounds (e.g., explosions, artillery blasts) can be felt as well as heard and utilize "C-Weighting" where the low-frequency components of these sounds are not de-emphasized to the same extent as A-weighting. Explanations of the noise metrics that are used in this assessment are listed below.

- **Day-Night Average Sound Level (DNL).** DNL is a noise metric describing the average noise level over the course of a 24-hour period. A 10 dB adjustment is applied to operations that happen during night time hours (10 p.m. through 7 a.m.) because noise tends to be more intrusive at night than during the day. DNL accounts for the total or cumulative noise level at a given location over a specified assessment (time) period. In the case of large caliber and aircraft noise, the assessment period is an annual average.

- **Maximum Sound Level (Lmax).** The highest sound level measured during a single event in which the sound level changes value with time (e.g., an aircraft overflight) is called the maximum sound level, or Lmax. The maximum sound level is important in judging the interference caused by a noise event with conversation, television or radio listening, sleeping, or other common activities.
- **Peak (dBP).** Peak is a single-event sound level without frequency weighting. There is no time component or assessment period with Peak such as with DNL. The peak level is the same day or night. It's also the same whether one round is fired or a thousand rounds fired at a given range. It is a singular measure of the peak sound produced at that instance.
- **PK15(met).** PK15(met) is a computer modeled single-event peak level that is exceeded only 15 percent of the time by the loudest munitions type detonation. This metric accounts for variations caused by weather conditions and favors noise propagation. The PK15(met) metric does not communicate any information about how often the loudest munitions type is detonated.
- **PK50(met).** PK50(met) is similar to the PK15(met) except that it represents the peak noise level that is exceeded 50 percent of the time. This metric also accounts for weather but assumes conditions which are not favorable for noise propagation, rather average or neutral weather conditions with regards to noise. The PK50(met) metric also does not communicate any information about how often the loudest munitions type is detonated.

## 1.4.2 SOUND PROPAGATION

The principle influence on sound propagation is weather. Wind and temperature significantly influence how far sound travels from a source and how loud it will be at the receiver's location. As sound travels through air, a receiver downwind of the source will be subjected to higher sound levels than a receiver upwind; in effect the wind is actually helping move the sound to the downwind receiver, while upwind the sound must "swim against the current."

Combine wind direction with temperature variation (as a rule, sound usually travels further in cold temperatures) and one may observe the phenomena of *atmospheric refraction*. This is the process by which atmospheric conditions actually bend and/or focus sound waves toward some areas and away from others.

When a temperature inversion is present, military operations may sound much louder than normal, or be heard at greater distances. The inversion layer acts as a boundary for the sound, trapping it close to the ground. This can create areas of high intensity sound far from the sound's source. As a result, on most days it may be possible to detonate 10 pounds of explosives without disturbing a community (neutral weather conditions), while on another day with a temperature inversion, the detonation of 1 pound at the same location may be disruptive (unfavorable weather conditions).

Figure 1-1 illustrates how temperature inversions bend (refraction) the sound created by a typical explosion. The sound waves from the explosion initially travel upward, but the inversion reflects the sound back downward toward the ground, generating high noise levels many miles away. Under normal conditions, the noise levels at that distance would otherwise be much lower.

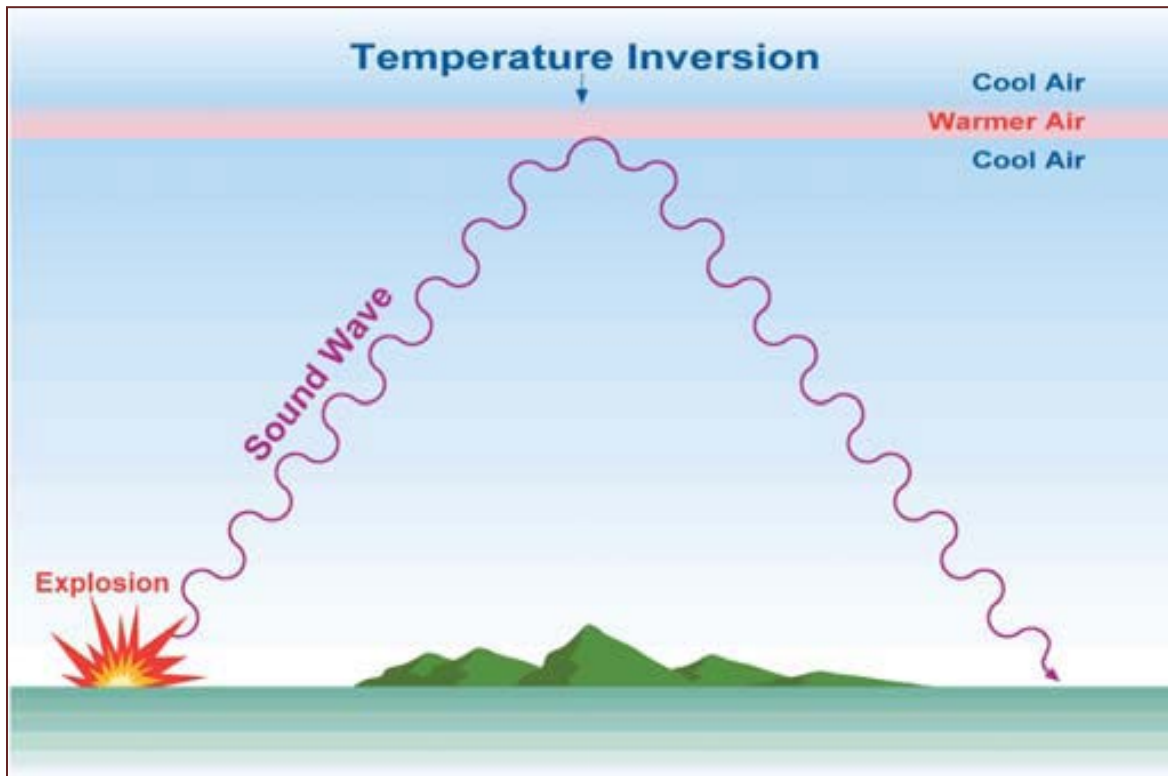


Figure 1-1. Example of a Temperature Inversion

Based on these phenomenon it is easy to see how predicting sound travel can be very difficult; however, the Explosives Research Group (ERG) and the University of Utah developed guidelines to help determine what would be “good” or “bad” firing times. These guidelines are summarized in Table 1-1.

Another factor in sound propagation can be the natural topography of the land in and around the firing ranges and impact areas, as well as outside the installation. Naturally-occurring terrain features have an effect on blast noise sound waves (air-blast) through both reflection and diffraction. To account for terrain effects, the BNOISE2 model uses algorithms in the calculation engine along with USGS Digital Elevation Model (DEM) data. It should be noted that the mitigation effects of topography on blast noise (i.e. large caliber weapons and demolitions) are highly dependent upon the terrain feature’s location and size.



Table 1-1. University of Utah Criteria for "Good" and "Bad" Firing Conditions

<b>“Good” Firing Conditions</b>	<b>“Bad” Firing Conditions</b>
<p>Clear skies with billowy cloud formations, especially during warm periods of the year.</p> <p>A rising barometer immediately following a storm.</p>	<p>Days of steady winds (5-10 mph) with gusts of greater velocities (above 20 mph) in the direction of nearby residences.</p> <p>Clear days on which “layering” of smoke or fog are observed.</p> <p>Cold, hazy, or foggy mornings.</p> <p>Days following a day when large extremes of temperature (about 36°F) between day and night are observed.</p> <p>Generally high barometer readings with low temperatures.</p>

Source: University of Utah, 1958

## **2 PENNSYLVANIA ARMY NATIONAL GUARD**

### **2.1 GENERAL**

The Pennsylvania National Guard which consists of the Pennsylvania Army National Guard (PAARNG) and the Pennsylvania Air National Guard (PAANG), is directed and supported by the Pennsylvania Department of Military and Veterans Affairs. Personnel include part-time citizen soldiers and airmen and full-time, active-duty soldiers and airmen, and state and federal civilian employees. The Pennsylvania National Guard has approximately 19,800 members in total, with 15,800 Army personal and 4,000 Air personnel (FTIG 2017b). The Pennsylvania Guard remains one of the largest and most highly mobilized National Guards in the nation.

### **2.2 MISSION AND ORGANIZATION**

The PAARNG mission is two-pronged, having both federal and state functions. PAARNG’s federal military mission is to assist the federal government in defending the sovereign interests of the United States, while the state mission is to protect the lives and property of Pennsylvania citizens during times of natural disaster and to preserve the peace, order, and public safety at the direction of the Governor.

Joint Force Headquarters for the PAARNG is located at Fort Indiantown Gap (FTIG), a large training center located in Annville, PA. FTIG is the only major military training center in Pennsylvania and the only live-fire training site in the state. The PAARNG also maintains two Army Aviation Support Facilities (AASF), one at the Muir Army Airfield (AASF #1) located on FTIG, and the other (AASF #2) located at the Johnstown-Cambria County Airport in Johnstown, PA. In addition to these larger training facilities, the PAARNG maintains and operates multiple Readiness Centers located throughout the state. Figure 2-1 shows the general location of PAARNG facilities within the state.

The largest element of the PAARNG is the 28th Infantry Division (ID), which is recognized as the oldest continuous serving division in the United States Army. The 28<sup>th</sup> ID consists of the following units:

- 2nd Infantry Brigade Combat Team
- 55th Maneuver Enhancement Brigade
- 56th Stryker Brigade Combat Team
- 28th Expeditionary Combat Aviation Brigade
- 28th Division Headquarters and Headquarters Battalion

The PAARNG’s other major unit, the 213th Regional Support Group, handles combat support missions, including transportation, finance and personnel services.

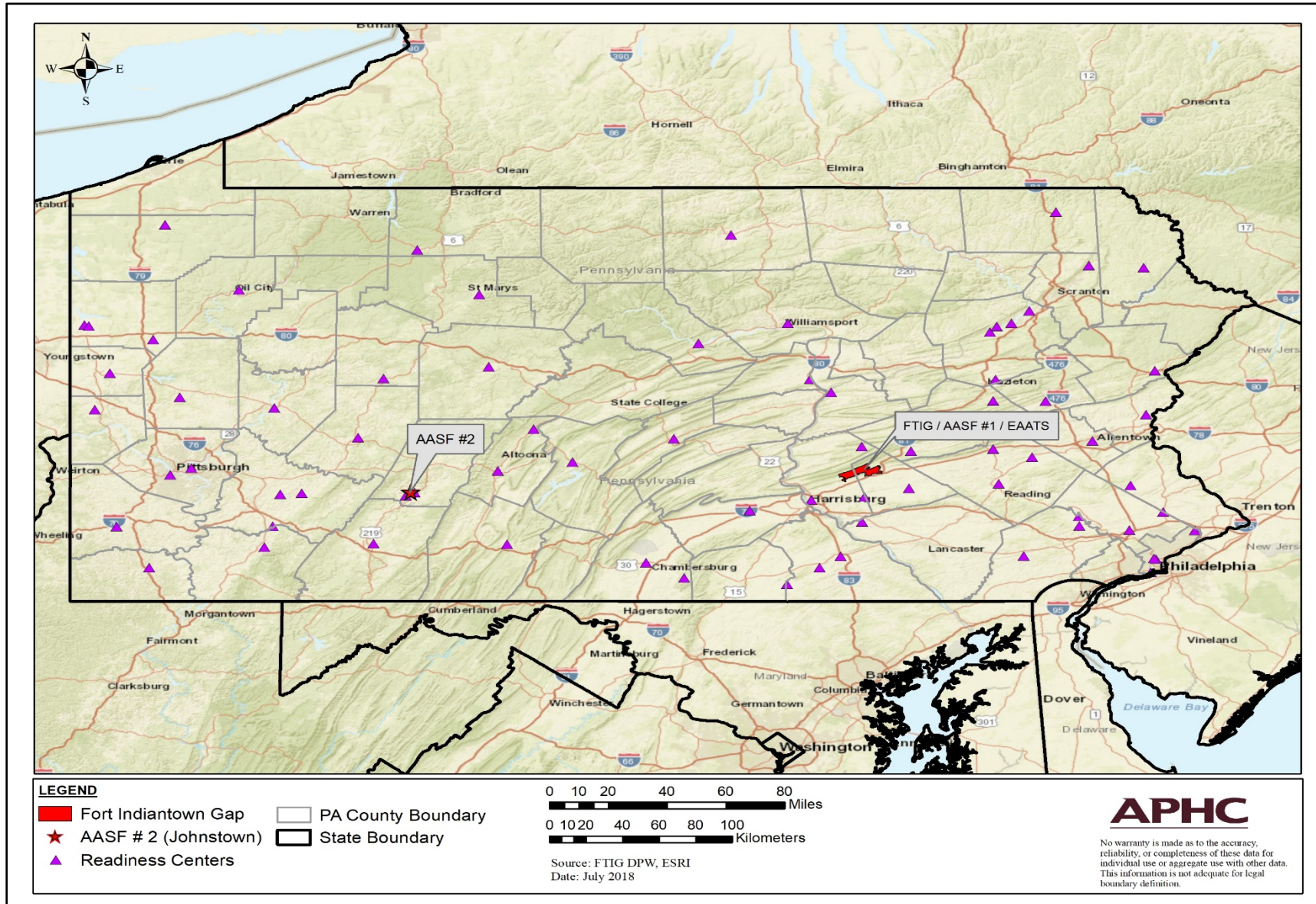


Figure 2-1. PAARNG Facility General Locations

In addition to its major units, the PAARNG also has three Army training schools:

- 166th Regiment - teaches leadership, military occupational and other officer/NCO skills.
- Eastern Army National Guard Aviation Training Site (EAATS) - teaches aviators from all components of the U.S. Army as well as multinational students. The training site administers a variety of courses on aircraft qualification and maintenance and operates the largest flight simulation complex in the reserve component.
- Medical Battalion Training Site - teaches vital medical skills.

### 2.3 PENNSYLVANIA NATIONAL GUARD ECONOMIC IMPACT

The operations at Pennsylvania National Guard facilities generate substantial revenues to local economies through military and civilian wages, equipment rentals, utilities, supplies, construction contractor payments and other prime contract awards. In FY 2016 alone, economic impacts to cities and counties throughout the state were in excess of 1.4 billion dollars. Table 2-3 shows the breakdown of total federal and state expenditures by the PA National Guard and the subsequent economic impact. The economic impact within the table is calculated at 1.68 times total expenditures. This economic impact multiplier derives from the Economic Impact of Military Installations used in the 2005 Base Realignment and Closure report.

Table 2-1. Pennsylvania National Guard Economic Impact

	<b>Total</b>
Federal Expenditures	\$679,048,064
State Expenditures	\$179,504,164
Federally Funded State Expenditures	\$140,432,776
Total Expenditures	\$858,552,228
Economic Impact	\$1,426,858,262

Source: DMVA 2016 - Economic Impact Report FY2016

FTIG is a major contributor to the economic health of the south-central Pennsylvania region, and the local economies of Lebanon and Dauphin counties, providing an economic impact of \$573 million a year. In addition to the more than 100,000 individual students and trainees who rotate through FTIG annually, approximately 2,100 people work full-time at FTIG; including military, civilians, contractors and other tenants.

## 2.4 NOISE MANAGEMENT PROGRAM

In accordance with AR 200-1, Army and ARNG installations are responsible for maintaining a Noise Management Program. The program includes two main components:

- (1). *Evaluate and document the impact of noise produced by ongoing and proposed actions/activities.*
- (2). *Monitor, record, archive and address operational noise complaints.*

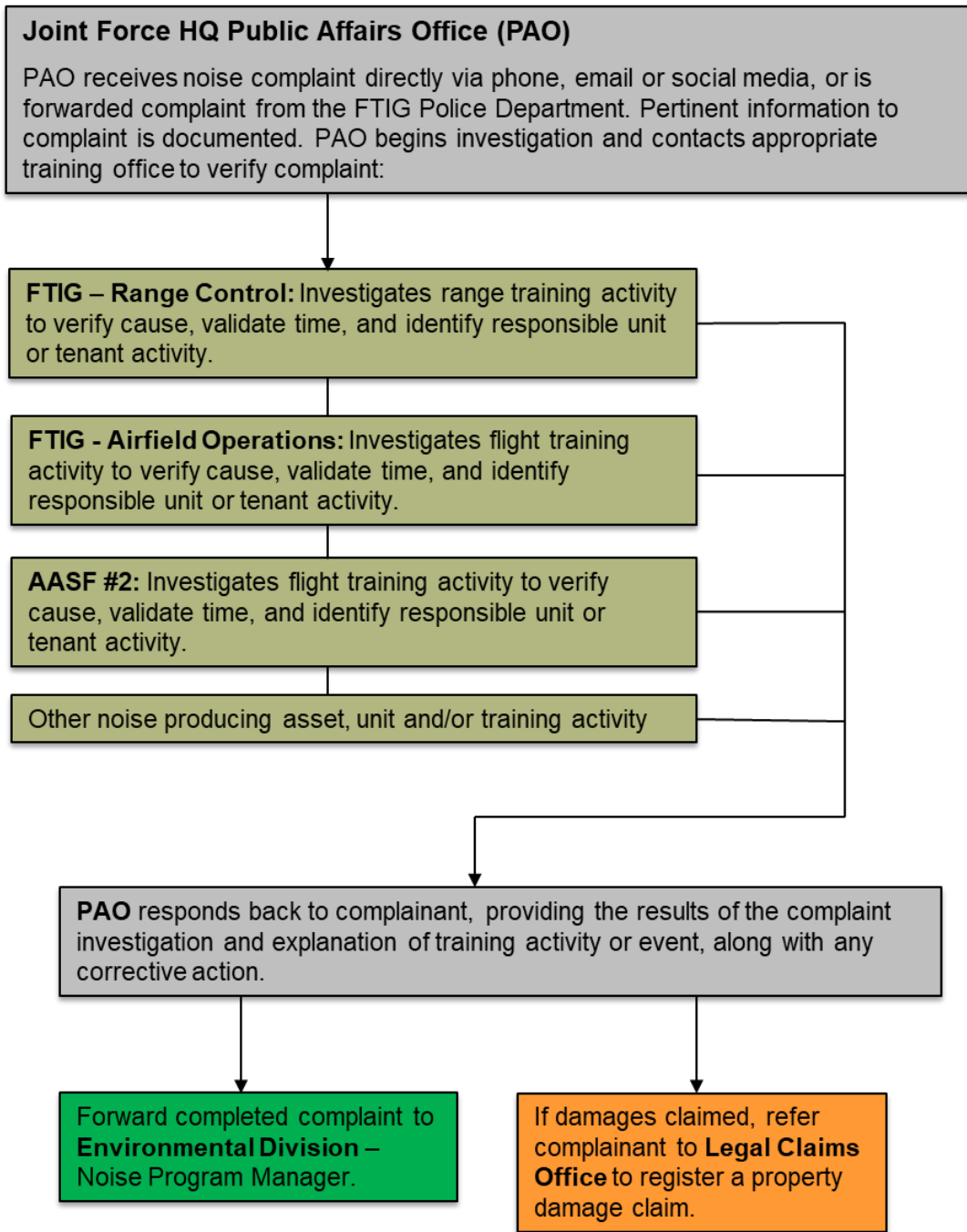
The ICUZ study is generally the center of the installation and or ARNG State noise management program. The ICUZ study along with an effective noise complaint procedure will help installations address complaints, advise local planning commissions, and be instrumental in developing action plans which may limit future encroachment threats.

### 2.4.1 NOISE COMPLAINT MANAGEMENT

The goal of a complaint procedure is to reduce the potential for noise complaints by keeping the public informed about what is happening and to satisfy the complainants so that noise complaints do not escalate. A proactive noise complaint program helps prevent the degradation of the mission due to controversy over noise impacts, while at the same time protecting the health and safety of the local community, both civilian and military, on and off the installation.

The Joint Force Headquarters Public Affairs Office (PAO) located on FTIG is responsible for community relations, media relations, and internal information for the Pennsylvania Department of Military and Veterans Affairs, PAARNG, and PAANG. This designates the PAO as the primary office for addressing noise and vibration complaints received from military training operations (U.S. Army 2012). The Joint Force PAO includes both a civilian press secretary (for liaison with the Governor’s Office) and a uniformed public affairs officer (for liaison with Department of Defense agencies).

The PAO maintains a public website, along with social media feeds (Facebook, Twitter and Flickr) in order to provide press releases, news, and information to the local community. With regard to military training noise, the PAO posts public notices which include advanced information about training exercises or special training events (Live-fire and/or Aviation etc.) which are expected to generate higher-than-normal noise levels off post. In the event a noise complaint is received, the following diagram below illustrates the basic complaint process:



### 3 NOISE ASSESSMENT GUIDELINES

The APHC recommends land use options based on the type of noise source. Table 3-1 lists the noise limits as shown in Army Regulation (AR) 200-1. Tables B-1 through B-3 (Appendix B) contain detailed land use recommendations for each noise source.

Table 3-1. Noise Limits for Noise Zones

Noise Zone	Noise Limits			Noise-Sensitive Land Use
	Aviation ADNL (dB)	Impulsive CDNL (dB)	Small Arms dBP	
LUPZ	60 – 65	57 – 62	n/a	Generally Compatible
I	< 65	< 62	< 87	Generally Compatible
II	65 – 75	62 – 70	87 – 104	Generally Not Compatible
III	> 75	> 70	> 104	Not Compatible

Source: AR 200-1

Notes: dB = decibel, ADNL = A-weighted Day-Night Level, CDNL = C-weighted Day-Night Level, P = Peak

There are often existing “noise-sensitive” land uses defined as non-conforming within a Noise Zone. In most cases this is not a risk to community quality of life or mission sustainment. Average noise levels may be the best tool for long-term land use planning, but they may not adequately assess the probability of community annoyance. As recommended in AR 200-1, this assessment includes supplemental metrics to identify where noise from aviation overflights, demolition activity, and large caliber weapons may periodically reach levels high enough to generate complaints. In many instances Noise Zones will indicate land use compatibility; however, noise complaints from impulsive noise, often referred to as blast noise, typically are attributable to a specific event rather than annual average noise levels. Peak levels are useful for estimating the risk of receiving a noise complaint from blast noise, as they correlate with the receiver’s perception of noise levels. Table 3-2 lists the Army’s Complaint Risk Guidelines.

Table 3-2. Complaint Risk Guidelines

Perceptibility	dBP	Risk of Receiving Noise Complaints
May be Audible	< 115	Low
Noticeable, Distinct	115 - 130	Moderate
Very Loud, May Startle	> 130	High
*Perceptibility is subjective. The classifications are based on how a typical person might describe the event.		

- People in an area experiencing peak sound pressure levels between 115 and 130 dB may describe events as noticeable and distinct. From within this area, the installation has a moderate risk of receiving noise complaints. The magnitude of the complaint risk is dependent upon frequency of occurrence in addition to factors such as time of day activity occurs, propagation conditions under which activity takes place, and noise sensitivity of individuals in these areas.
- Peak sound pressure levels above 130 dB are generally objectionable, and are often described as very loud and startling. These levels correlate with a high risk of noise complaints.
- If the operations which generate high peak sound pressure levels in the community are very infrequent, land use controls may not be warranted. However, prior public notification is important for mitigating complaint risk, and also an import role of being good neighbors.
- Peak sound pressure levels directly correlate with airborne vibration which is the dominant cause of structural response from military training. Peak sound pressure levels above 120 dB may rattle windows or loose ornaments (e.g. pictures on walls) and annoy occupants but will not cause structural damage. It is widely recognized that structural damage is improbable when peak sound pressure levels do not exceed 140 dB.

Peak levels can vary significantly for the same activity dependent on weather conditions. Thus, supplemental metric Peak noise contours are modeled with the following weather conditions applied:

- Unfavorable Weather Conditions: PK15(met) is the peak sound level, factoring in the statistical variations caused by weather, that is likely to be exceeded only 15 percent of the time (i.e., 85 percent certainty that sound will be within this range). This “85 percent solution” gives the installation and the community a means to consider the areas that at times may be impacted by training noise. PK15(met) levels would occur under unfavorable weather conditions that enhance sound propagation.
- Neutral Weather Conditions: PK50(met) is the Peak level that is likely to be exceeded 50 percent of the time (i.e., 50 percent certainty that sound will be within this range). These levels would be seen during neutral weather conditions. It should be noted that if activities take place under favorable weather conditions, such as the wind blowing away from the receiver, noise levels would be lower.

The unfavorable weather conditions PK15(met) metric is a good tool to indicate areas that may periodically be exposed to high noise levels. When land use planning programs such as real estate disclosure, a Joint Land Use Study or the Army Compatible Use Buffer are implemented, the PK15(met) complaint risk areas can and should be used to delineate areas of focus. However, since the complaint risk areas are based on individual event levels and are not dependent on the number of events, planners should also consider frequency of operations when making land use decisions.



## 4 FORT INDIANTOWN GAP

### 4.1 LOCATION

Fort Indiantown Gap (FTIG) is located in south-central Pennsylvania, in portions of northwest Lebanon County and eastern Dauphin County, approximately 22 miles northeast of the state capital, Harrisburg (Figure 4-1). FTIG is approximately five miles wide (north to south) and eleven miles long (east to west), occupying roughly 17,100 acres of land.

### 4.2 LOCAL COMMUNITIES

The largest urban centers in the region are Harrisburg and its incorporated suburbs to the southwest, and the City of Lebanon to the southeast. Dauphin County ranks 15<sup>th</sup> out of 67 counties in Pennsylvania for total population. As evidenced in Table 4-1, both Dauphin and Lebanon County have maintained positive growth trends at 2.8 and 4.6 percent population change since 2010. Although, this growth has been relatively modest, it far out paces the state average of less than one percent.

Table 4-1. Regional Population Summary Surrounding FTIG

	2000	2010	2017 (Est)
Lebanon	24,448	25,477	25,770
Harrisburg	48,861	49,528	49,192
Lebanon County	120,327	133,568	139,754
Dauphin County	251,798	268,100	275,710
Pennsylvania	12,281,054	12,702,379	12,805,537

Source: U.S. Census Bureau

The majority of land that surrounds FTIG is rural in nature. Land uses in the immediate vicinity are composed primarily of forestland, agricultural, and low-density residential organized into separate townships (Figure 4-2). There are some privately-owned properties (inholdings) within FTIG, many with occupied houses.

The northern border of FTIG is adjacent to Pennsylvania State Game Lands (SGL), designated as SGL 211, situated on Second Mountain. The land is used primarily for conservation and hunting and is home to a Boy Scout Camp and multiple smaller state park facilities. Union Township lies east of FTIG, where land uses are primarily agricultural and open space, with some low-density residential and limited commercial and manufacturing. U.S. Interstate 81 runs along the southern boundary of the FTIG cantonment area. The Union and East Hanover (Lebanon County) Townships are located south of FTIG’s boundary and main entrance. Again, land uses in these areas consist of agriculture, forestland, and low-density rural residential. The western end of FTIG lies within the East Hanover Township (Dauphin County), while also bordering the West Hanover Township to the northwest. The land west of the installation is primarily forestland with limited residential and agricultural uses (JLUS 2015).

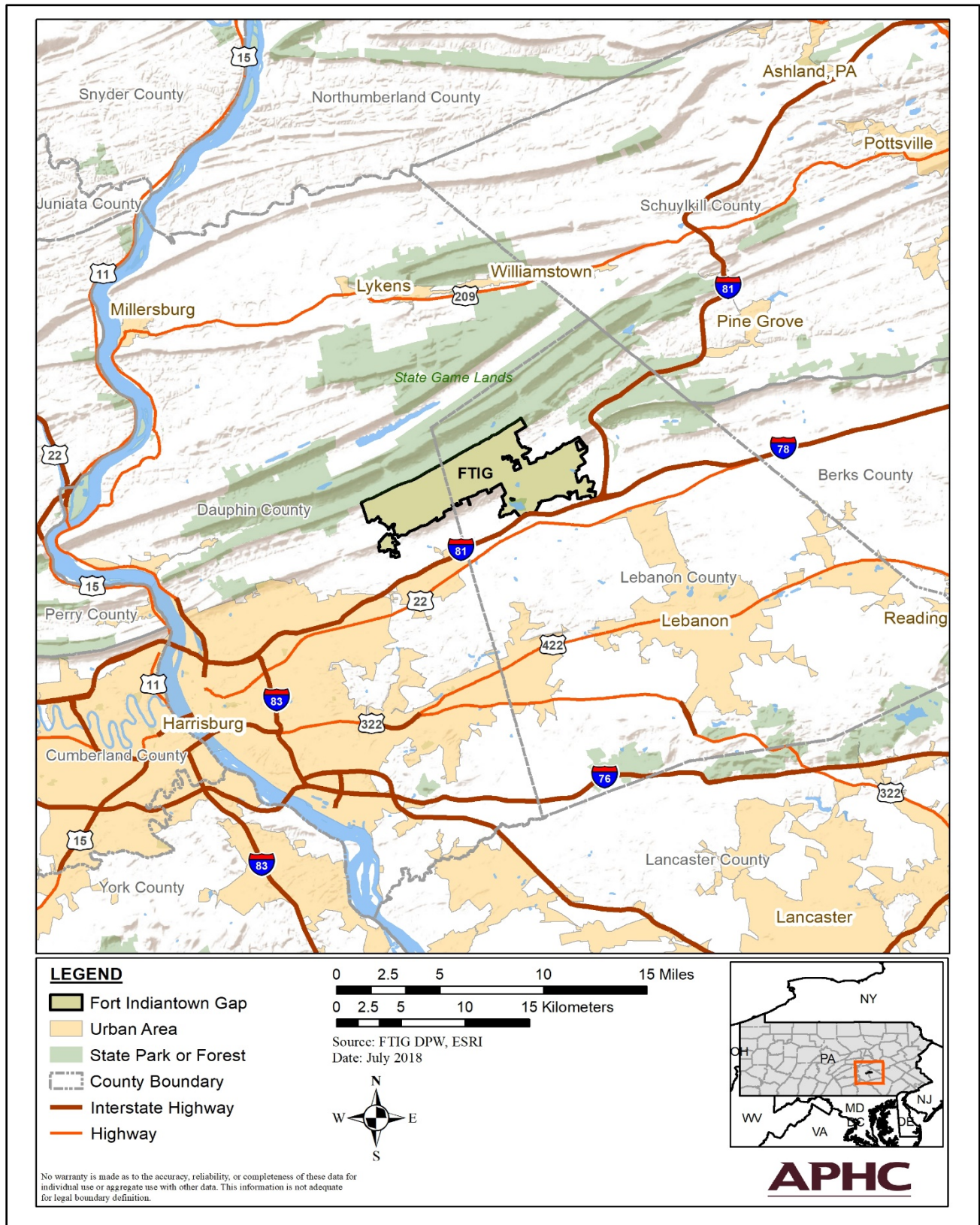


Figure 4-1. FTIG General Location

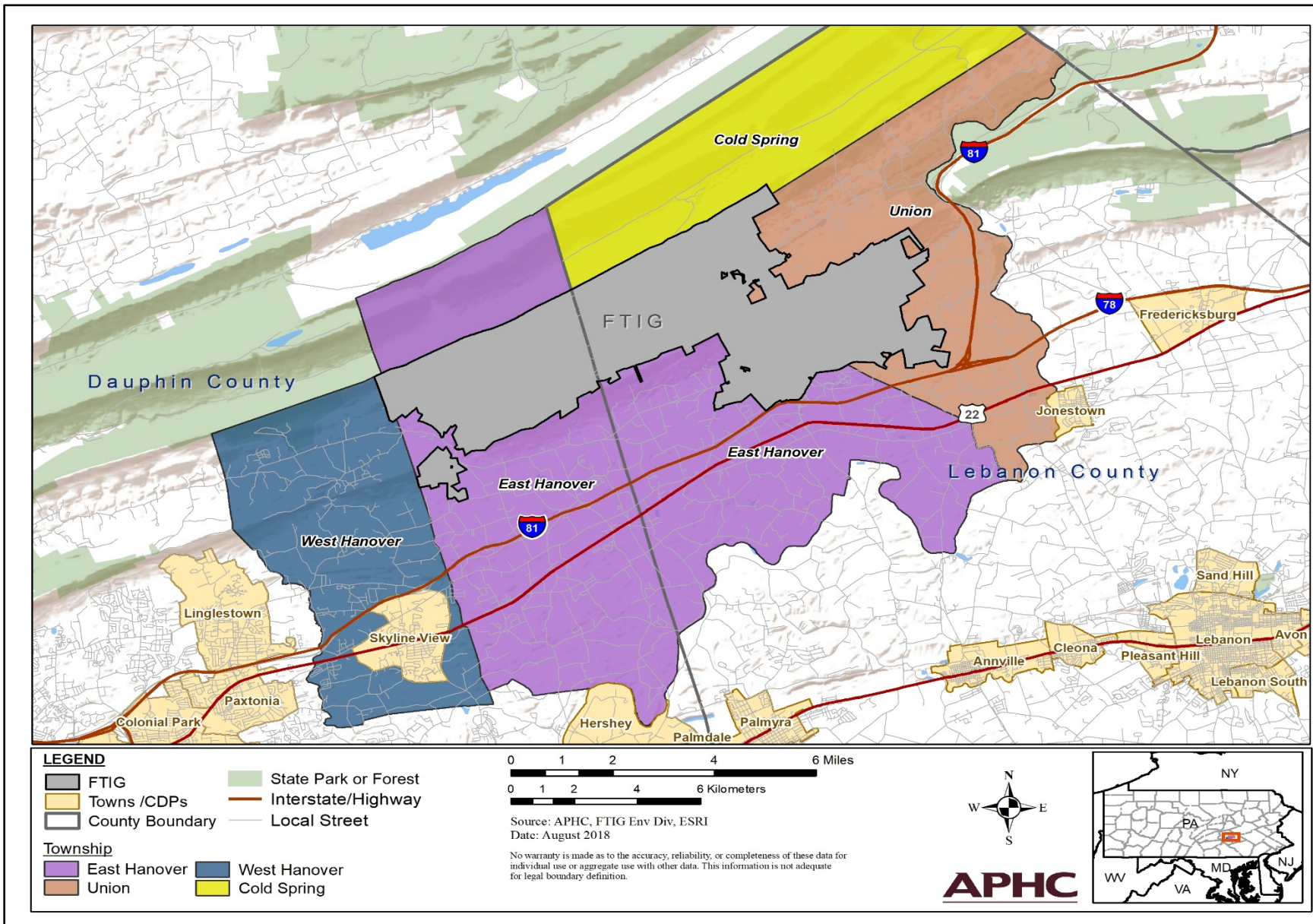


Figure 4-2. Local Townships Surrounding FTIG

### 4.3 RANGES AND TRAINING

FTIG has a multitude of specific training facilities available to support individual skills, collective training, unit tactics, convoy training, drills, and weapons system proficiency and qualification. The main training corridor on FTIG is roughly 11,000 acres, and is bounded by Second Mountain to the north and Blue Mountain to the south. Training facilities include live-fire ranges and demolition areas, maneuver areas, vehicle training areas, an air-to-ground bombing range, rotary-wing operations areas, combat urban assault courses, breach facilities and combat simulators. There are two impact areas on FTIG; one duded and one non-duded. Tables 4-2 and 4-3 list specific small and large caliber ranges on FTIG available to training units.

Table 4-2. Small Arms Ranges

Range	Range Type
RG 3	BASIC 10M-25M FIRING RANGE (ZERO)
RG 4	COMBAT PISTOL/MP FIREARMS QUALIFICATION COURSE
RG 5	BASIC 10M-25M FIRING RANGE (ZERO)
RG 5A	BASIC 10M-25M FIRING RANGE (ZERO)
RG 5B	BASIC 10M-25M FIRING RANGE (ZERO)
RG 6	SCALED GUNNERY RANGE
RG 7	COMBAT PISTOL/MP FIREARMS QUALIFICATION COURSE, AUTOMATED
RG 8	AUTOMATED RECORD FIRE (ARF) RANGE
RG 8	BASIC 10M-25M FIRING RANGE (ZERO)
RG 9Q	AUTOMATED RECORD FIRE (ARF) RANGE
RG 9Z	BASIC 10M-25M FIRING RANGE (ZERO)
RG 10	BASIC 10M-25M FIRING RANGE (ZERO)
RG 11	MODIFIED RECORD FIRE RANGE
RG 12A	KNOWN DISTANCE (KD) RANGE
RG 13	BASIC 10M-25M FIRING RANGE (ZERO)
RG 13A	BASIC 10M-25M FIRING RANGE (ZERO)
RG 14	BASIC 10M-25M FIRING RANGE (ZERO)
RG 14A	BASIC 10M-25M FIRING RANGE (ZERO)
RG 15	BASIC 10M-25M FIRING RANGE (ZERO)
RG 17	NON-STANDARD SMALL ARMS RANGE
RG 23E	NON-STANDARD SMALL ARMS RANGE
RG 24A	NON-STANDARD SMALL ARMS RANGE
RG 24B	NON-STANDARD SMALL ARMS RANGE
RG 24C	NON-STANDARD SMALL ARMS RANGE
RG 25	MACHINE GUN TRANSITION RANGE
RG 27	AUTOMATED MULTIPURPOSE TRAINING RANGE (MPTR)
RG 34	AUTOMATED INFANTRY SQUAD BATTLE COURSE
RG 35	AUTOMATED MULTIPURPOSE MACHINE GUN (MPMG) RANGE
RG 36	MACHINE GUN QUALIFICATION RANGE, 40MM (GRENADE)
RG 37	AUTOMATED SNIPER FIELD FIRE RANGE
RG 38	MACHINE GUN FIELD FIRE RANGE
RG 38	KNOWN DISTANCE (KD) RANGE

Table 4-3. Large Caliber Training Ranges / Facilities

Range/ Facility	Range Type
RG 2	GRENADE LAUNCHER RANGE
RG 6	TANK/FIGHTING VEHICLE SCALED GUNNERY RANGE (1:5 and 1:10)
RG 18	HAND GRENADE QUALIFICATION COURSE (NONFIRING)
RG 18A	HAND GRENADE ACCURACY COURSE (NONFIRING)
RG 19	HAND GRENADE FAMILIARIZATION RANGE (LIVE)
RG 23A	HAND GRENADE FAMILIARIZATION RANGE (LIVE)
RG 23C	RANGE, LIGHT ANTIARMOR WEAPONS (LAW/AT-4) LIVE
RG 23D	GRENADE LAUNCHER RANGE
RG 35	MULTI-PURPOSE MACHINE GUN RANGE
RG 36	MK-19, 40MM (GRENADE)
RG 37	AUTOMATED SNIPER FIELD FIRE RANGE
RG 38	MACHINE GUN FIELD FIRE RANGE
Demo B	LIGHT DEMOLITION RANGE
Demo D	LIGHT DEMOLITION RANGE
Mine Detection Site	MINE WAREFARE AREA

In addition to the ranges listed in Table 4-3, FTIG has multiple direct and indirect Artillery and Mortar firing point/areas scattered throughout the training corridor. There are fifty training areas suitable for bivouac, maneuver, and other customized training. Multiple training areas may be linked together to create large corridors for lanes training. Training areas are approved for simulators (pyrotechnics) and small arms weapons fire using blank ammunition.

Table 4-4 lists the collective training facilities on FTIG. All of these sites are designed to closely replicate realistic conditions and effects in the urban battlefield. The collective training facilities are heavily used by military units and law enforcement entities. Figure 4-3 illustrates the range and training area locations on FTIG.

Table 4-4. Collective Training Facilities

Range/ Facility	Range Type
RG 20	MOUT / URBAN ASSAULT COURSE (UAC)
RG 30	COMBINED ARMS COLLECTIVE TRAINING FACILITY (CACTF)
RG 31	URBAN ASSAULT COURSE
RG 32	LIVE FIRE EXERCISE SHOOTHOUSE
RG 33	LIVE FIRE EXERCISE BREACH FACILITY
RG 39	IMPROVISED EXPLOSIVE DEVICE (IED) DEFEAT FACILITY

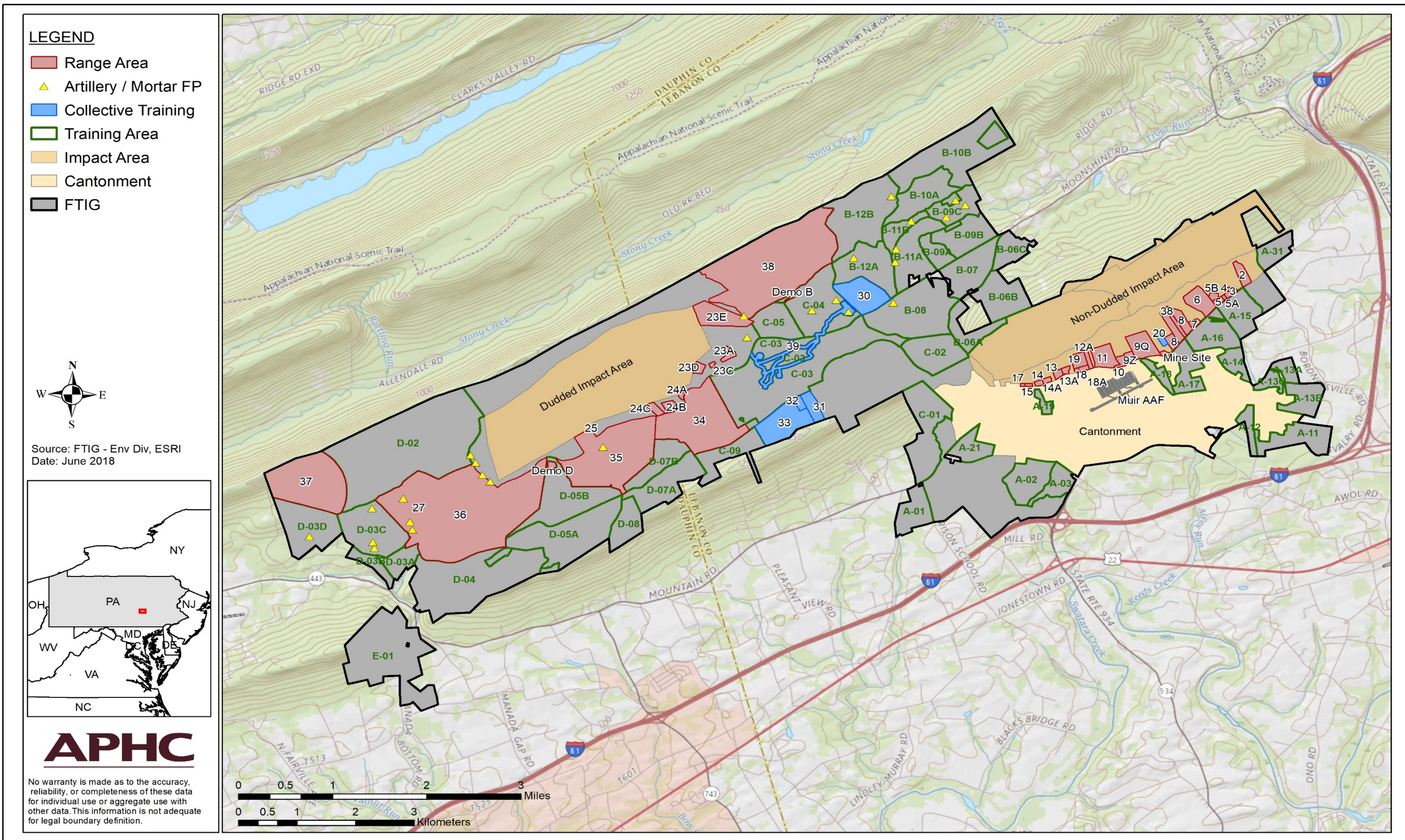


Figure 4-3. FTIG Range and Training Area Locations

## 4.4 RANGE NOISE ASSESSMENT

### 4.4.1 SMALL ARMS NOISE

The small arms designation includes weapons of .50 caliber or less. Small arms weapons utilized at FTIG include a multitude of rifles, machine guns, pistols, and shotguns with various ammunition. The SARNAM model was used to calculate and plot the peak noise levels based on the loudest weapon at each small arms range from the operations data described in Appendix C. To generate noise contours using SARNAM, specific firing point and target point locations must be entered into the program. Therefore, ranges without set firing points or target point locations such as firing at collective training facilities and urban terrain facilities are addressed via predicted peak noise levels in the Non-fixed Firing Point Area subsection.

### 4.4.2 SMALL ARMS NOISE ZONES

The small arms ranges at FTIG are operational year round depending upon training mission requirements, such as the type of training to be completed; the unit being trained; and deployment status. Based on range records from FY 2016-2017, small arms ammunition expenditures at FTIG averaged over five million rounds per year.

The Noise Zones for small arms firing activity are illustrated in Figure 4-4. These Noise Zones represent a maximum small arms training scenario (all ranges actively firing) for live-fire ammunition operations. As previously mentioned, there is no assessment period with the Peak noise metric. Thus, only Noise Zones II and III are depicted in the map figures (Note: Zone I includes all areas outside the Zone II noise limit of 87 dBP).

The SARNAM model allows for berms and backstops when calculating sound levels, but does not account for detailed natural topography. Studies have shown that neighboring hills and/or mountains can act as barriers, greatly reducing noise impacts from firing. Therefore, to account for the mountainous terrain at FTIG along the northern and southern boundaries, adjustments were made to the Noise Zones, based on attenuation characteristics of small arms weapons. For small arms ranges and detonations of less than 1 kilogram of explosive, it has been found that a characteristic frequency of 200 Hertz (Hz) provides calculation results which show marked attenuation. A 200 Hz frequency characteristic equates to a wavelength of roughly 6 feet. When considering the 500 to 1,000 foot terrain rises beyond the ranges at FTIG, the considerably smaller wavelengths of small arms weapons would be greatly reduced by these barrier effects.

The Noise Zones from small arms firing are split between the range complex at the non-dudded impact area in the eastern portion of FTIG, and the ranges in the central and western portions of the Fort. Zone II extends beyond the FTIG boundary east approximately 500 meters (m); north up to 610 m; south approximately 715 m; and west just over 1 kilometer (km). Zone III extends beyond the boundary in one area west, approximately 125 m outside Range 37. Table 4-5 lists the acreages for each small arms Noise Zone.

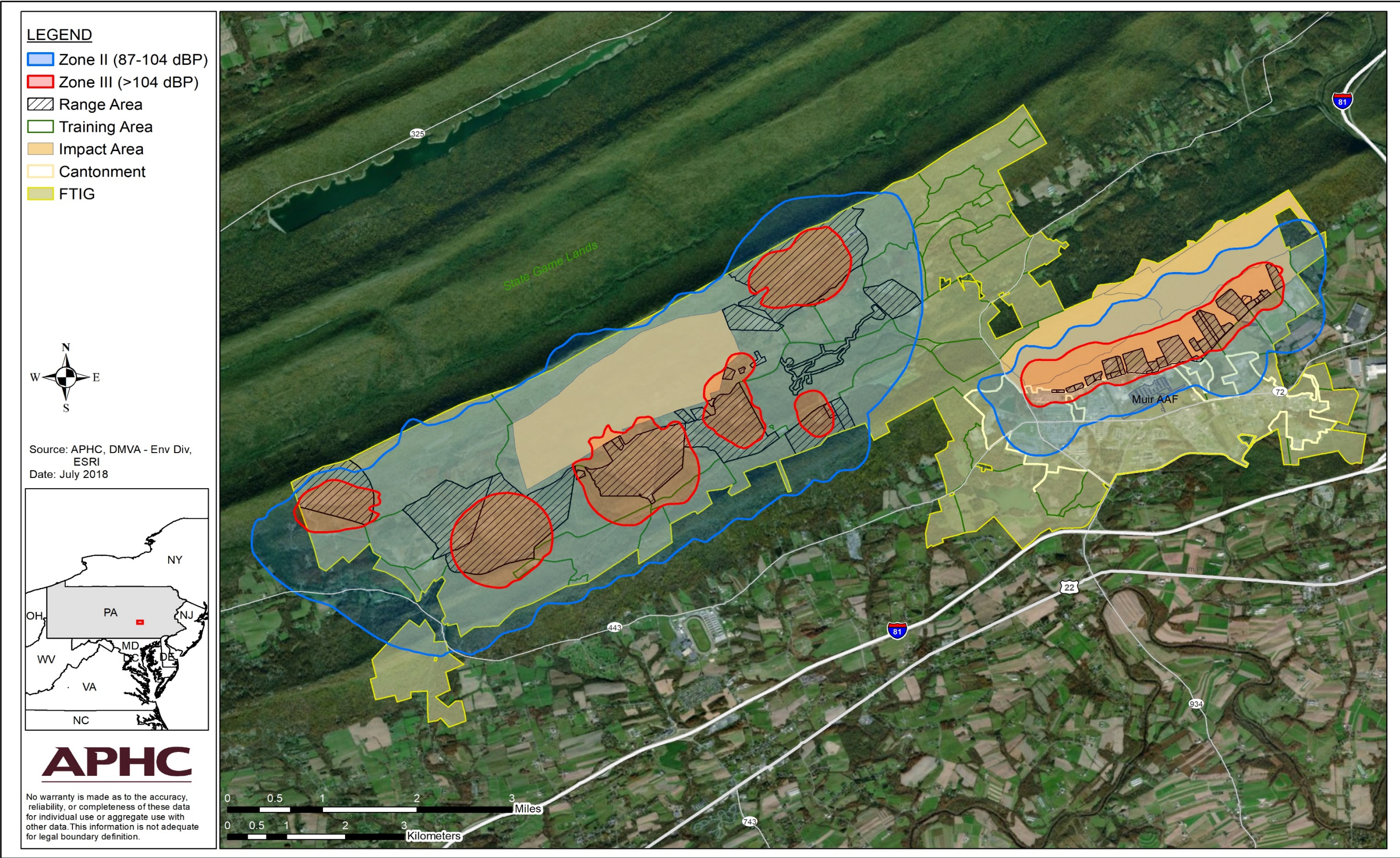


Figure 4-4. FTIG Small Arms Noise Zones



Table 4-5. Small Arms Noise Zones Acreage

Noise Zone	Noise Zone Acreage		
	Total	Cantonment	Off Post
Zone II	10,802	661	2,233
Zone III	3,243	88	10

Land use within Zone II off post is primarily forest land, with some pasture and agricultural lands. A few scattered residences are contained within the Zone II areas east and south of the boundary, with the largest concentration of residential land use occurring west of FTIG, along State Highway 443 (Figure 4-5). The areas north are uninhabited State Game Lands. The ten acres of Zone III beyond the west boundary do not contain any noise-sensitive land use.

On post, Zone II extends from the range complex south as far as Fisher and Letterman Roads, encompassing the Airfield property, along with several barracks and family housing structures on the west end of the cantonment. Zone III extends just south of the ranges into the cantonment. Structures contained within the Zone III are primarily storage and equipment sites. Zone III does encompass an EAATS dormitory building, located just beyond Range 11. Table 4-6 lists the daytime and nighttime ambient population exposure within the Noise Zones on and off post, based on an analysis using the LandScan™ dataset. The highest concentration of affected population occurs on post in the cantonment during daytime and off post during nighttime hours. However, it should be noted that small arms training predominantly occurs during daytime hours, which significantly reduces noise exposure off post.

Table 4-6. Population Exposure in Small Arms Noise Zones

Population	Noise Zone	
	Zone II	Zone III
<b>Off Post</b>		
Daytime	37	0
Nighttime	167	0
<b>On Post (Cantonment)</b>		
Daytime	222	11
Nighttime	8	0

Note:

Land Analysis Ambient Population Exposure: The LandScan™ ambient population estimates used in this plan are based on the 2013 annual mid-year national population estimates from the Geographic Studies Branch, U.S. Bureau of Census.<sup>1</sup> The daytime and nighttime LandScan™ data were derived based on the habits and movements of people over a day. Whereas a national census only measures the population based on residences, the LandScan™ dataset measures areas where people tend to be during a typical day. For instance, traveling along roadways to get to a destination or where they may work.<sup>2</sup> Nighttime estimates are representative of residential figures.

<sup>1</sup> This product was made utilizing the LandScan (2012)™ High Resolution global Population Data Set copyrighted by UT-Battelle, LLC, operator of Oak Ridge National Laboratory under Contract No. DE-AC05-00OR22725 with the United States Department of Energy. The United States Government has certain rights in this Data Set.

<sup>2</sup> <http://www.personal.psu.edu/ddj118/Geog482/Project3.html>

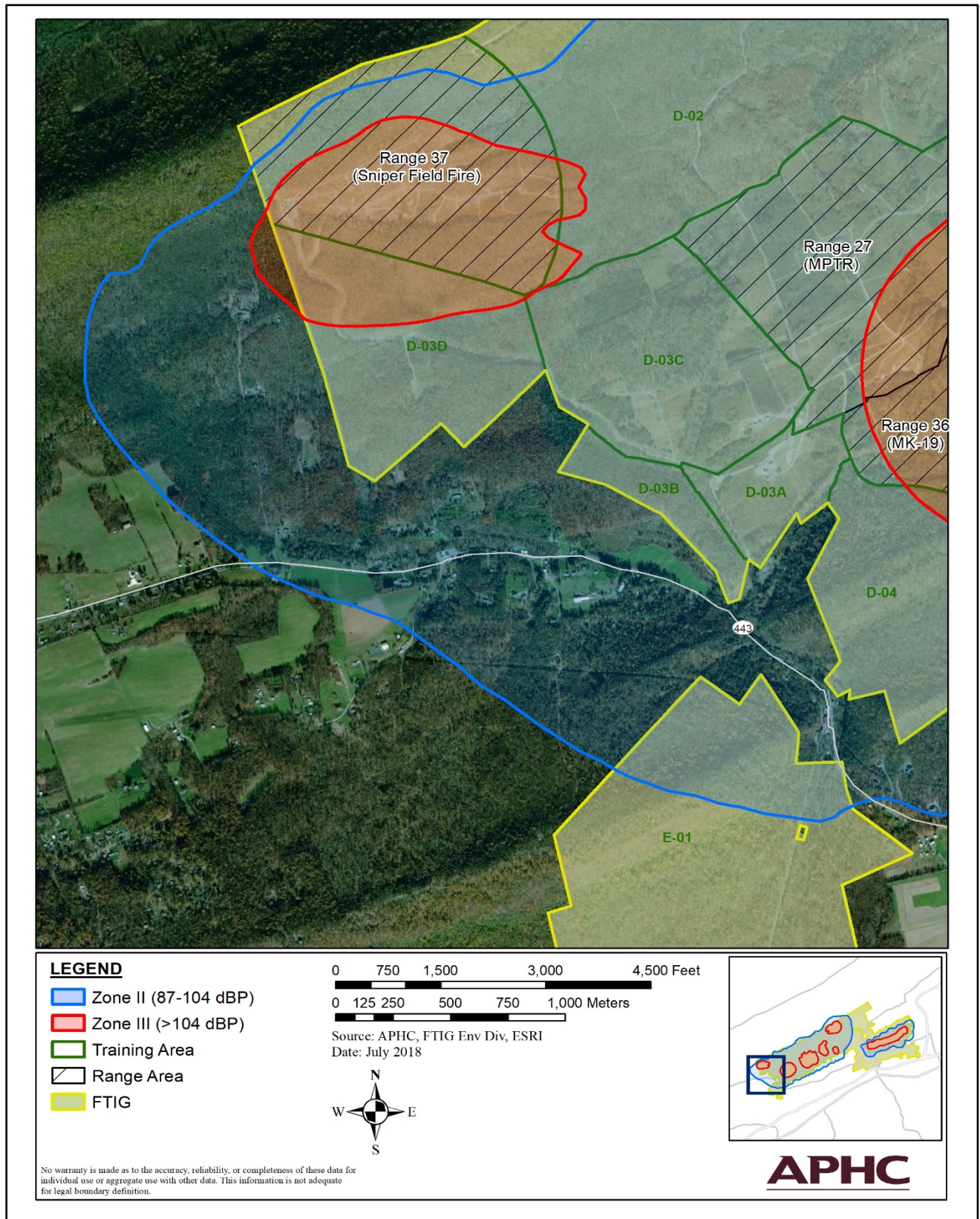


Figure 4-5. FTIG Small Arms Noise Zones Extending West

**4.4.3 NON-FIXED FIRING SMALL ARMS AREAS**

Military units at FTIG conduct training at multiple collective training facilities and training areas using blank ammunition and/or simunitions. These activities produce training which replicates real-world environments and scenarios. With the absence of specific firing and target point locations, noise contours for these activities cannot be modeled. However, by looking at predicted peak levels of small arms, we can assess noise exposure from these training activities.

Tables 4-7 and 4-8 list the predicted peak levels for commonly used rifle and machine gun blank ammunition on FTIG. In each column, the upper limit levels would occur under weather conditions that enhance sound propagation (unfavorable), such as the wind blowing toward the receiver. The lower limit levels occur under favorable weather conditions, such as the wind blowing away from the receiver. The azimuth angle can be defined as the direction of fire, i.e. 0 degrees is directly in front of the weapon and 180 degrees is directly behind the weapon.

When combining these variables, the highest peak levels occur when rounds are fired in the direction of the receiver (0 degree azimuth) and under unfavorable weather conditions. As an example, Table 4-3 indicates that under unfavorable weather conditions, a Zone II noise level [87 dBP] extends approximately 200 m for the 5.56 mm blank round at all three given azimuth angles.

Table 4-7. Predicted Peak Levels for 5.56 mm Blank Round

Distance, meters	Predicted Level, dBP Azimuth		
	0°	90°	180°
100	87-97	86-96	87-97
200	80-90	79-89	80-90
400	69-79	68-78	69-79

Note: the 0° is directly in front of the weapon and the 180° azimuth is directly behind the weapon.  
 Blank is defined as any round that contains propellant but no bullet.  
 Highlighted row indicates where noise approaches/exceeds Zone II levels.

Table 4-8. Predicted Peak for 7.62 mm Blank Round

Distance, meters	Predicted Level, dBP Azimuth		
	0°	90°	180°
100	109-119	106-116	101-111
200	103-113	100-110	94-104
400	92-102	89-99	85-95
800	84-94	81-91	77-87

Note: the 0° is directly in front of the weapon and the 180° azimuth is directly behind the weapon  
 Blank is defined as any round that contains propellant but no bullet.  
 Highlighted row indicates where noise approaches/exceeds Zone II levels.

Based on the distances listed above, in most instances, training operations firing blank ammunition will not produce noise levels at or above the Zone II limit of 87 dBP beyond the FTIG boundary. Collective training facilities on FTIG are primarily centrally located. However, several maneuver training areas located along the east and west boundaries are used to fire machine guns. These training exercises do possess the potential for higher noise levels beyond the boundary. It should be noted that variables such as actual firing location within the training area, direction of weapon fire, and weather conditions at the time of firing would all determine the degree of noise impact.

#### **4.4.4 LARGE CALIBER AND DEMOLITION NOISE**

The large caliber designation includes weapons 20 mm or greater and any weapon that contains explosive charges. This designation also includes all demolition charges. At FTIG, training is conducted with a multitude of large caliber weapons including artillery, mortars, aerial gunnery, mines, grenade launchers, and explosive demolition charges. Training operations occur all year round, however, higher training volumes occur from spring through fall (March through November) and taper off in the winter months. Typical weekend training events last from Thursday to Sunday with firing generally occurring Friday through Sunday midday. The preponderance (~90 percent) of all large caliber weapons firing and demolition operations occur during daytime hours at FTIG.

In addition to the firing points and ranges assessed in the Noise Zones, training at FTIG also includes utilization of simulators (pyrotechnic and non-pyrotechnic). Simulator noise levels are much lower than noise levels generated by the munitions they replicate. Simulators are not included in the Noise Zones and are addressed separately via peak noise levels in Section 4.2.2.1.

#### **4.4.5 LARGE CALIBER AND DEMOLITION NOISE ZONES**

Figure 4-6 depicts the CDNL Noise Zones for large caliber and demolition operations. Appendix C lists the large caliber ammunition and explosive detonations expenditures by range and type used to produce the Noise Zones. The Noise Zones were modeled using an assessment period of 104 days, with 10 percent night firing, and terrain effects applied (Note: All demolition operations are modeled during daytime hours).

The LUPZ extends beyond the FTIG boundary north approximately 225 m; south up to 450 m; east approximately 1.4 km (0.8 miles); and west 1.5 km (0.9 miles). Zone II extends beyond the FTIG boundary in a similar manner, extending as far as the mountain ridgeline along the northern and southern boundary. Zone II extends in one area northeast approximately 1.1 km and in two separate areas west up to 560 m. Zone III also extends in one area east approximately 460 m and one small area west less than 175 m.

On post, the Noise Zones extend south into the cantonment from Grenade qualification operations at Range 19. Table 4-9 lists the acreages for the CDNL Noise Zones.

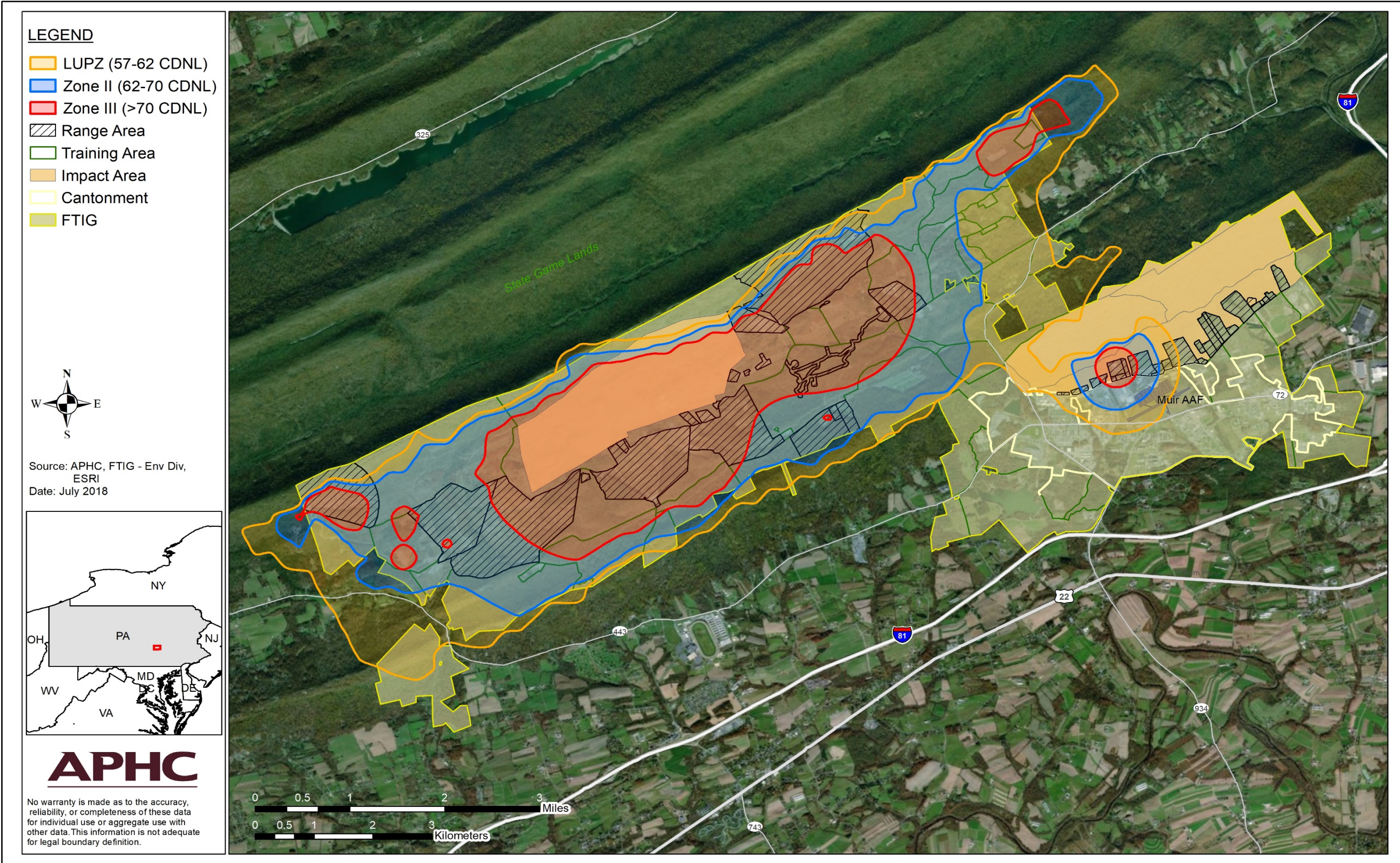


Table 4-9. Large Caliber and Demolition Noise Zones Acreage

Noise Zone	Noise Zone Acreage		
	Total	Cantonment	Off Post
LUPZ	4,155	219	1,649
Zone II	4,541	109	399
Zone III	5,087	13	58

Land use within the Noise Zones off post is primarily forest and SGL, agricultural and low-density residential. Table 4-10 lists the daytime and nighttime ambient population exposure (LandScan™) totals within the Noise Zones off post and those portions extending into the cantonment areas on post. As evidenced in the Table, population exposure within Zone II and Zone III is extremely low, particularly off post. Figures 4-7 and 4-8 illustrate the Zones II and III extending beyond the west and east boundaries. Residential land uses are common along State Highway 443 on each end of the Fort within the LUPZ. Several homes along the west boundary are just along and/or outside the Zone II. There are no noise-sensitive land uses contained in Zone III.

Noise exposure on post is generally limited to daytime hours. The LUPZ contains several transient troop barracks facilities west of the airfield and family housing facilities along Clement Road. Zone II also contains several enlisted barracks buildings adjacent to the airfield and several homes contained within the inholdings on the east end of the training corridor. Zone III is limited to storage facilities and vehicle maintenance shops in the cantonment.

Table 4-10. Population Exposure in Large Caliber and Demolition Noise Zones

Population	Noise Zone		
	LUPZ	Zone II	Zone III
<b>Off Post</b>			
Daytime	26	1	0
Nighttime	150	1	0
<b>On Post* (Cantonment Area)</b>			
Daytime	117	52	0
Nighttime	1	9	0

\* On Post calculation includes Inholding areas outside of the Cantonment.

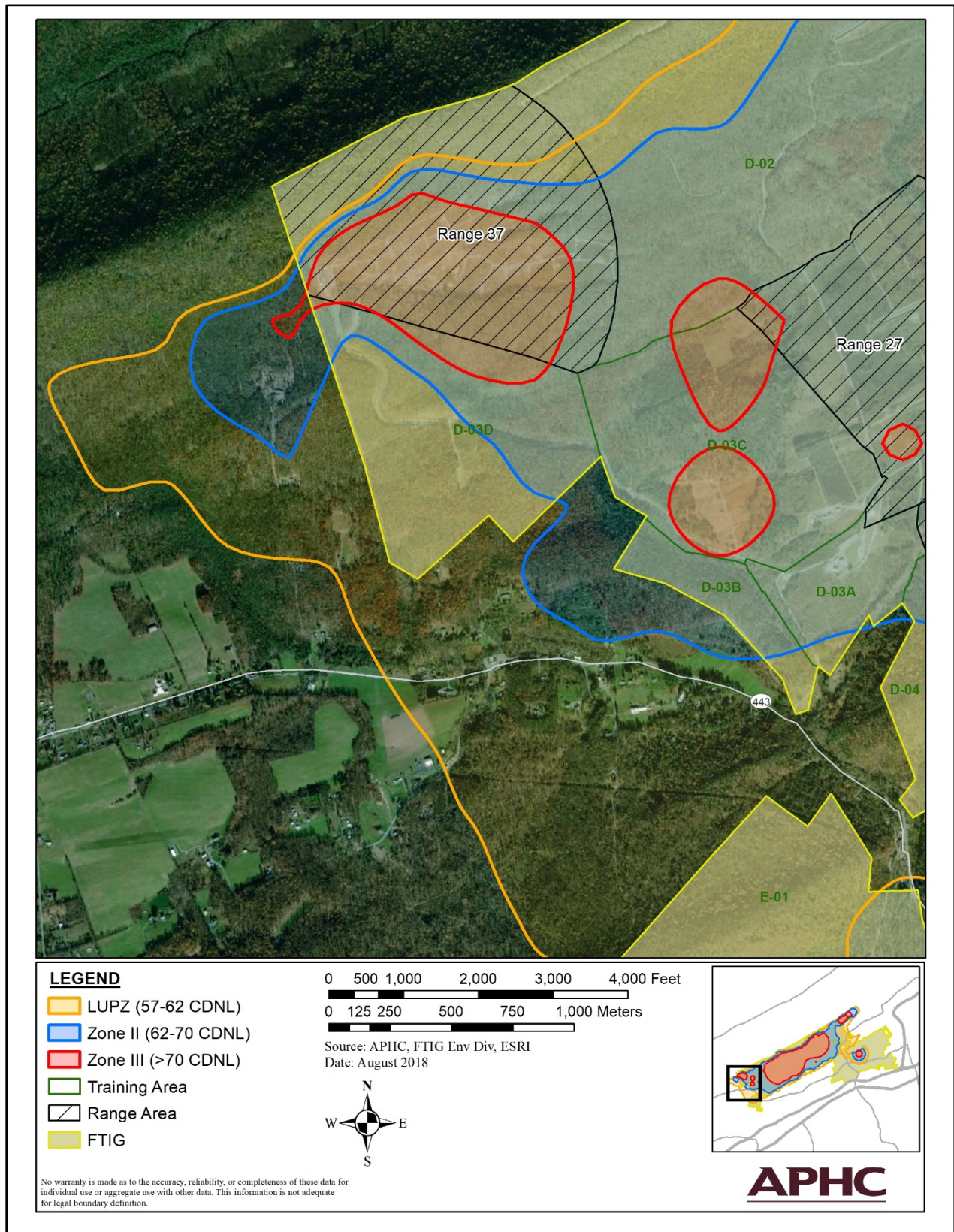


Figure 4-7. FTIG CDNL Noise Zones Extending West

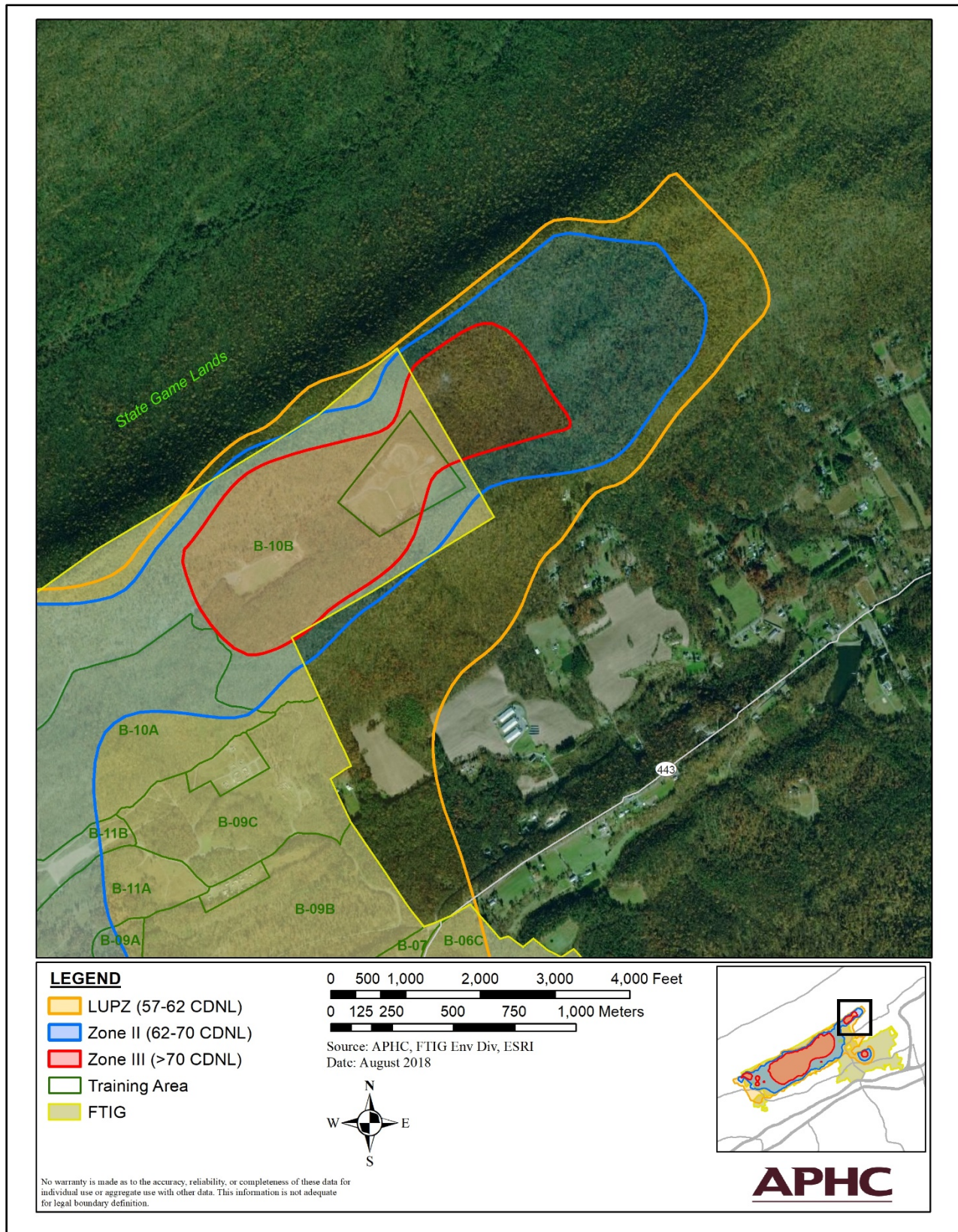


Figure 4-8. FTIG CDNL Noise Zones Extending East



#### 4.4.6 LARGE CALIBER AND DEMOLITION SINGLE EVENT PEAK LEVELS

Annual average noise levels are suitable for long-term land use planning; however, individual training events can be audible outside of a Noise Zone and in some cases objectionable to the surrounding community. Peak level assessments can forecast where sound may be audible or loud from singular events. Table 3-2 (Section 3) listed the perceptibility of Peak sound levels. It is worth noting that vibration that often accompanies low-frequency noise from large caliber weapons is almost always air-borne (not ground-borne). Neighbors located near the “loud” area on the map may occasionally notice picture or window rattling from air-borne vibration; however, this rattling does not indicate damage, and usually occurs at levels well below those required to cause structural damage.

Figures 4-9 and 4-10 depict the single event Peak sound level contours for large caliber weapons operations using different weather conditions. Figure 4-9 illustrates weather conditions that enhance sound propagation (unfavorable weather) and Figure 4-10 illustrates more favorable propagation conditions (neutral weather). Both weather scenarios are provided to demonstrate the influence of meteorological conditions on noise propagation. The same range records (Appendix C) used to produce the CDNL Noise Zones were used to create the Peak contours.

##### **Unfavorable Weather – PK15(met)**

Under unfavorable weather, peak sound levels between 115 and 130 dB extend beyond the boundary to the north approximately 610 m; east 4.1 km (2.5 miles); west 3 km (1.8 miles); and south up to 1.1 km (0.6 miles). Again, the presence of Second and Blue Mountains running north and south along the main training corridor show substantial attenuation effects. The greatest impacts occur in the valleys east and west of FTIG, where single-family residences are common. The 115-130 dB noise contour also extends south of the cantonment as far as Interstate 81. The land in this area is comprised primarily of Fort Indiantown Gap National Cemetery.

Peak sound levels above 130 dB extend beyond the boundary in one area northeast, approximately 825 m; several areas west up to 300 m; and one area south of Range 33, approximately 550 m. There are no sensitive land uses contained within these areas. However, there are multiple single-family homes just beyond the contour northeast and along the southwest boundary. Thus, during weather that favors propagation, these homes may receive a greater-than-normal noise dose from large caliber weapons training.

On post, peak sound levels between 115 and 130 dB blanket the majority of the cantonment, along with Memorial Lake State Park, several in-grant areas, and an inholding area adjacent to TA B-06. Peak sound levels above 130 dB within the cantonment are primarily driven by Grenade and Claymore activity at Range 19. Multiple troop barracks and family housing buildings are encompassed within the 130 dB contour on post. In addition, two inholding areas containing several occupied homes are contained within the 130 dB contour.



Figure 4-9. Large Caliber and Demolition Operations PK15(met) Sound Levels



Figure 4-10. Large Caliber and Demolition Operations PK50(met) Sound Levels

**Neutral Weather – PK50(met)**

Under neutral weather conditions, peak sound levels between 115 and 130 dB extend beyond the boundary east, west and south; however, in more localized fashion. The contour contracts considerably, extending east approximately 1.2 km (0.7 miles), south 590 m, and west up to 480 m. Land use is primarily forest, however, several scattered residential properties are contained within the area southwest of FTIG, and along the south boundary.

Peak sound levels above 130 dB in the neutral weather scenario extend beyond the installation boundary in one small area east (165 m), along with one small area south (218 m). There are no sensitive land uses contained in either of these areas.

On post, sound levels between 115 and 130 dB once again extend south from Range 19 (Grenade qualification operations), encompassing a large portion of the cantonment. Sensitive land uses on post are primarily troop barracks and some limited family housing facilities. Inholding areas on the east end of the main training corridor are also included in the 115-130 dB contour. On occasion these buildings may be subjected to loud noise levels. Peak sound levels above 130 dB in the cantonment are primarily confined to the airfield which does not contain any sensitive land use.

**4.5 SIMULATOR NOISE**

Simulator noise levels vary depending on the type (i.e., artillery, ground burst, grenade, improvised explosive device) but typically, the variation will be limited to a few decibels. Table 4-7 gives an approximation of anticipated noise levels under neutral and unfavorable weather conditions. The levels were generated using the BNOISE2 computer program, and then verified by comparing the levels with results from noise monitoring studies (U.S. Army 1983, U.S. Army 1984, U.S. Army 1989). Based on Table 4-7, under neutral weather conditions, the risk of complaints will be low beyond 500 m as the Peak level would not exceed 115 dBP. Under unfavorable weather conditions, such as during a temperature inversion, or when there is a steady wind blowing in the direction of the receiver, the distance to a 115 dBP level increases to approximately 800 m.

Table 4-11. Predicted Peak Noise Levels for Typical Army Simulators

<b>Distance from source (Meters)</b>	<b>Neutral Weather Conditions PK50(met) dBP</b>	<b>Unfavorable Weather Conditions PK15(met) dBP</b>
100	134	136
200	125	130
300	120	127
400	117	123
500	114	121
600	111	118
700	109	116
800	107	114

Note: Highlighted cells indicate where peak noise levels approach 115 dB.

Simulators on FTIG are used in multiple collective training facilities and maneuver training areas. As was the case with non-fixed small arms training, simulators may be deployed during exercises in locations near the installation boundary. However, when compared to the high explosive large arms and demolition activities that take place at FTIG, in most cases, the noise from simulator training is not expected to create a high risk of complaints.

#### **4.6 AIRCRAFT NOISE**

FTIG accommodates a broad spectrum of aviation training and maintenance activities for both permanently stationed 28th Expeditionary Combat Aviation Brigade (ECAB) aircraft, Eastern Army National Guard Aviation Training Site (EAATS) aircraft, transient unit rotary-wing aircraft, and PAANG fixed-wing aircraft.

The Local Flying Area (LFA) spans a large portion of the state of Pennsylvania and stretches into several neighboring states to the north, east, and south. Local regulated airspace at FTIG consists of the Muir Army Airfield (Muir AAF) airspace, defined by a five statute mile radius centered on the airfield, and the Restricted Area, R-5802 (A/B/C/D/E). Regulated airspace is managed by the Muir AAF tower, and R-5802 usage is coordinated by FTIG Range Control. Figure 4-11 illustrates the aviation operations areas at FTIG.

The Northern Training Area (NTA), located north of FTIG on state games lands and private property, is divided into Areas A, B, and C for tactical flight training with 25 separate landing zone areas. Nap of the Earth (NOE) and terrain flight operations are only authorized within the boundaries of the state game and forest lands.

There are four drop zones on FTIG, however, West Field DZ, located in TA A-1 is the primary DZ used for parachute/paradrop operations, two Maintenance Test Flight (MTF) areas (Western and Eastern) used for MTF procedures and the Bollen Range (FTIG 2017a). Bollen Range is a fixed-wing air-to-ground bombing range located inside the impact area within R-5802. The range is utilized by U.S. Air Force fixed-wing for bombing and strafing operations using inert ordnance.

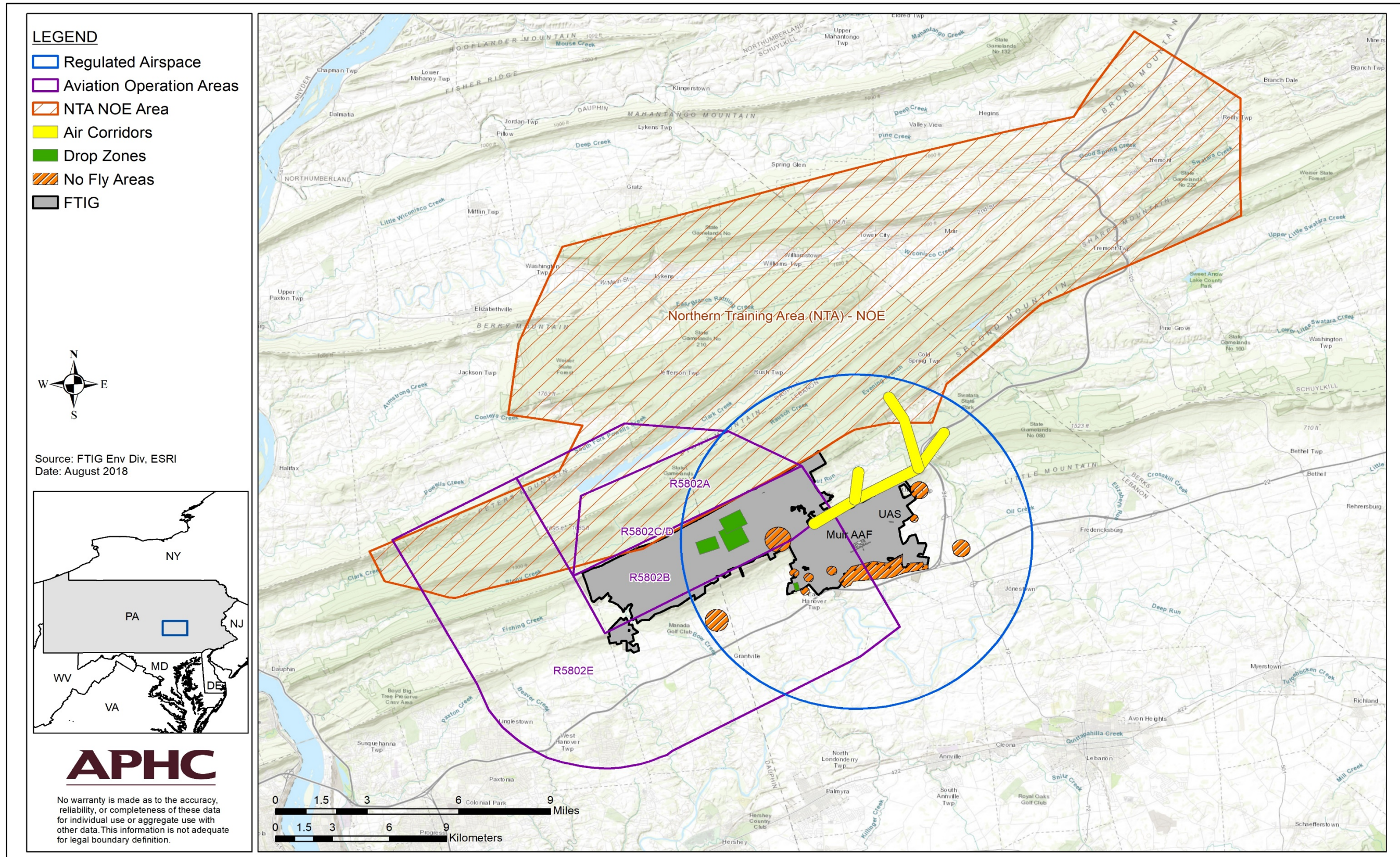


Figure 4-11. FTIG Airspace and Aviation Operation Areas

**4.6.1 MUIR ARMY AIRFIELD**

Muir AAF is located in the north-central portion of the cantonment, just south of the range complex. The airfield has one main runway and two helipads. The runway, designated 7/25, orients northeast to southwest and is approximately 3,978 feet in length. The airfield elevation is approximately 487 feet above mean sea level (MSL). Muir AAF is home to the AASF #1 and host unit the 28<sup>th</sup> ECAB, as well as the EAATS, both of which are the primary users of the airfield.

**4.6.1.1 MUIR ARMY AIRFIELD NOISE ZONES**

The number of military aircraft operations at an airfield varies from day to day. However, the NOISEMAP modeling software requires input of a specific number of daily aircraft flights and aircraft maintenance engine run-up operations. Thus, operations are calculated for an average annual day (AAD), meaning that operations are averaged across all 365 days of the year. The AAD was used in this assessment to generate A-Weighted Day-Night Level (ADNL) Noise Zones for Muir AAF. Appendix C contains the traffic count summary inputs for the Noise Zones.

Figure 4-12 illustrates the Noise Zones for Muir AAF aircraft operations. Operations at Muir AAF consist of rotary-wing aircraft only. Table 4-12 lists the acreage calculations for each Noise Zone. The LUPZ extends off post east approximately 1.4 km (0.8 miles), west 400 m, and south up to 1.4 km (0.8 miles), crossing Interstate 81. Zone II extends beyond the boundary east approximately 1.2 km (0.7 miles) and south 920 m outside of the main cantonment. Zone III does not extend beyond the FTIG boundary. Land use within the Zone II area east is a mix of agricultural, forest, commercial (along State Highway 72), and residential. Land use in the Zone II area south is primarily National Cemetery lands.

Table 4-12. Muir AAF Noise Zones Acreage

Noise Zone	Noise Zone Acreage		
	Total	Cantonment	Off Post
LUPZ	2,094	250	923
Zone II	3,118	1,387	932
Zone III	182	160	0

On post, the LUPZ contains some range lands north of the airfield, and areas west of the cantonment, including a portion of the Memorial Lake State Park and several state-controlled in-grant areas. The LUPZ also contains an inholding area with several homes and church adjacent to the state park. The location of the airfield and subsequent aircraft traffic pattern exposes a large portion of the cantonment area to Zone II noise levels. Sensitive land use within Zone II is generally troop barracks and family housing facilities. Zone III extending west of Runway 7, contains several shop facilities, warehouse and storage facilities, and several non-military housing structures on Clement Avenue.



Figure 4-12. Muir Army Airfield ADNL Noise Zones



As evidenced in Table 4-13, the affected population numbers are highest on post during daytime hours with a significant drop at night. Conversely, the exposure off post increases during nighttime hours. These numbers are primarily attributable to the residential land uses east of the FTIG boundary.

Table 4-13. Population Exposure in Muir AAF Noise Zones

Population	Noise Zone		
	LUPZ	Zone II	Zone III
<b>Off Post</b>			
Daytime	232	37	0
Nighttime	93	122	0
<b>On Post (Cantonment Area)</b>			
Daytime	48	450	97
Nighttime	0	35	0

#### 4.6.2 ANNOYANCE POTENTIAL FROM SINGULAR OVERFLIGHT

Although the Noise Zones address annual noise exposure in and around Muir AAF, individual aircraft overflights beyond the airfield, transitioning to or training within the LFA, generate noise levels that some individuals might find disruptive and/or annoying. This can be particularly true for military aircraft which tend to perform training activities which are repetitive and at low altitude. Rotary-wing aircraft flying along the installation boundary or in the NTAs and C-130 fixed-wing aircraft utilizing the drop zones are just a few examples of these activities. Singular aircraft overflight is often the culprit of noise complaints received by an installation.

Scandinavian Studies (Rylander 1974) found that a good predictor of annoyance at airfields with 50 to 200 operations per day is the maximum level of the 3 loudest events. While annoyance levels may be lower along less-frequented aviation routes and flight corridors, the Rylander study serves as an indicator for annoyance potential from intermittent overflights, and provides a measure of the intrusiveness of an individual event.

Maximum sounds levels from rotary-wing aircraft operating at Muir AAF and common fixed-wing aircraft using the airspace and facilities at FTIG are listed in Tables 4-14 and 4-15. These levels are compared against the levels listed in Table 4-16 to determine the percent of the population that may consider itself highly annoyed from a singular overflight.

Table 4-14. Maximum A-Weighted Sound Levels for Rotary-Wing Aircraft

Slant Distance (feet)	Maximum Sound Level, dBA <sup>1</sup>				
	AH-64 <sup>2</sup> 70 KIAS	CH-47 <sup>2</sup> Light ^130 KIAS	CH-47 <sup>2</sup> Heavy* ^120 KIAS	UH-60 <sup>2</sup> 70 KIAS	UH-72 <sup>2</sup> ^123 KIAS
200	90	101	98	86	87
500	82	93	89	77	78
1,000	75	87	83	71	72
1,500	71	83	79	67	68
2,000	68	80	76	64	65
2,500	65	78	74	61	62

<sup>1</sup> During flyover at constant airspeed.

\* Heavy = sling load

<sup>2</sup> Obtained via AAM Program (Wyle 2013)

KIAS = Knots Indicated Air Speed

<sup>^</sup> Only KIAS available in single track mode

Table 4-15. Maximum A-Weighted Sound Levels for Fixed-Wing Aircraft

Slant Distance (Feet)	Maximum Sound Level , dBA <sup>1</sup>				
	C-130 970 C TIT 170 kts	C-17 90% NC 250 kts	C-12 90% RPM 160 kts	C-5 2.5 EPR 250 kts	C-23 99% RPM 160 kts
500	92	97	79	114	79
1,000	85	89	73	108	73
1,500	80	84	69	101	69
2,000	77	79	67	97	67
2,500	75	76	65	89	65
5,000	66	73	57	77	57

<sup>1</sup> Obtained via SelCalc Program (U.S. Air Force 2005)

Table 4-16. Percentage of Population Highly Annoyed from Aircraft Noise

Maximum Sound Level , dBA	% Highly Annoyed
90	35
85	28
80	20
75	13
70	5

Source: Rylander 1974

Taking the Rylander correlation one step further, the SelCalc Program (U.S. Air Force 2005) was used to calculate the distance in ground track from zero to where the maximum A-weighted noise level would decay to 70 dBA or below (threshold for annoyance). This takes into account not only those directly under a flight path but those to the side of a passing aircraft, where noise levels may remain high enough to cause annoyance up to one-half mile away.

Tables 4-17 and 4-18 are based on typical AGL altitudes for stationed rotary-wing aircraft and transient fixed-wing cargo aircraft. All of these aircraft have the potential to operate at relatively low altitudes at or near the FTIG boundary, or just beyond in the local airspace depending on the type of training mission.

The tables list the ground track distance, maximum sound level, and subsequent annoyance potential, and represent the best strategy for predicting areas that may be impacted based on annoyance potential from singular overflight. Current flight routes can be amended or future routes can be delineated based on the distances in the Tables, to further avoid the overflight of noise-sensitive areas.

Table 4-17. Rotary-Wing Overflight Annoyance Potential<sup>1</sup>

Source	Ground Track Distance <sup>2</sup>	dBA Maximum <sup>3</sup>	Percent Population Highly Annoyed <sup>4</sup>
AH-64 – 500’ AGL 70 KIAS	0’	82	23
	1,320’ (1/4 mile)	73	10
	1,760’ (1/3 mile)	69	4
	2,640’ (1/2 mile)	65	<1
AH-64 – 1,000’ AGL 70 KIAS	0’	75	13
	1,320’ (1/4 mile)	71	7
	1,760’ (1/3 mile)	69	4
	2,640’ (1/2 mile)	65	<1
CH-47 Light – 500’ AGL 130 KIAS	0’	93	+35
	1,320’ (1/4 mile)	94	+35
	1,760’ (1/3 mile)	93	+35
	2,640’ (1/2 mile)	90	+35
	5,280’ (1 mile)	70	5
CH-47 Light – 1,000’ AGL 130 KIAS	0’	87	31
	1,320’ (1/4 mile)	85	28
	1,760’ (1/3 mile)	84	26
	2,640’ (1/2 mile)	83	25
	5,280’ (1 mile)	81	22
CH-47 Heavy* – 500’ AGL 120 KIAS	0’	89	34
	1,320’ (1/4 mile)	77	16
	1,760’ (1/3 mile)	74	11
	2,640’ (1/2 mile)	70	5
	5,280’ (1 mile)	63	<1
CH-47 Heavy* – 1,000’ AGL 120 KIAS	0’	83	25
	1,320’ (1/4 mile)	77	16
	1,760’ (1/3 mile)	75	13
	2,640’ (1/2 mile)	70	5
	5,280’ (1 mile)	63	<1
UH-60 – 500’ AGL 70 KIAS	0’	77	16
	1,320’ (1/4 mile)	68	2
	1,760’ (1/3 mile)	64	<1
UH-60 – 1,000’ AGL 70 KIAS	0’	71	7
	1,320’ (1/4 mile)	67	1
	1,760’ (1/3 mile)	65	<1

<sup>1</sup> Percent annoyance shown is based upon 50 to 200 overflights per day. (Rylander 1974)

<sup>2</sup> Distance between receiver and the point on Earth at which the aircraft is directly overhead.

<sup>3</sup> Obtained via AAM Program (Wyle 2013)

<sup>4</sup> Calculated percentage based upon regression using the known values in Table 4-16.

+35% The Rylander studies did not include sampling in excess of 90 dBA.

\* Heavy = sling load

Table 4-18. Fixed-Wing Overflight Annoyance Potential<sup>1</sup>

Source	Ground Track Distance <sup>2</sup>	dBA Maximum <sup>3</sup>	Percent Population Highly Annoyed <sup>4</sup>
C-130 – 500’ AGL	0’	92	+35
	1,320’ (1/4 mile)	80	20
	1,760’ (1/3 mile)	77	16
	2,640’ (1/2 mile)	72	8
	5,280’ (1 mile)	62	<1
C-130 – 1,000’ AGL	0’	85	28
	1,320’ (1/4 mile)	79	19
	1,760’ (1/3 mile)	77	16
	2,640’ (1/2 mile)	72	8
	5,280’ (1 mile)	64	<1
C-130 – 2,000’ AGL	0’	77	16
	1,320’ (1/4 mile)	75	13
	1,760’ (1/3 mile)	74	11
	2,640’ (1/2 mile)	71	7
	5,280’ (1 mile)	64	<1
C-17 – 500’ AGL	0’	97	+35
	1,320’ (1/4 mile)	84	26
	1,760’ (1/3 mile)	80	20
	2,640’ (1/2 mile)	73	10
	5,280’ (1 mile)	62	<1
C-17 – 1,000’ AGL	0’	89	34
	1,320’ (1/4 mile)	82	23
	1,760’ (1/3 mile)	79	19
	2,640’ (1/2 mile)	74	11
	5,280’ (1 mile)	63	<1
C-17 – 2,000’ AGL	0’	79	19
	1,320’ (1/4 mile)	77	16
	1,760’ (1/3 mile)	75	13
	2,640’ (1/2 mile)	72	8
	5,280’ (1 mile)	64	<1

<sup>1</sup> Percent annoyance shown is based upon 50 to 200 overflights per day. (Rylander 1974)

<sup>2</sup> Distance between receiver and the point on Earth at which the aircraft is directly overhead.

<sup>3</sup> Obtained via SelCalc Program (U.S. Air Force 2005)

<sup>4</sup> Calculated percentage based upon regression using the known values in Table4-16.

+35% The Rylander studies did not include sampling in excess of 90 dBA.

**4.6.3 BOLLEN AIR-TO-GROUND RANGE**

The Bollen Air-to-Ground Weapons Range Complex is a Joint use Class A Range that is operated by Detachment 1 of the Air Force 193rd Special Operations Wing. The range is located inside the duded impact area on FTIG in the main training corridor. Bollen Range provides a realistic, tactical range environment for Air-to-Ground, Airdrop, and Joint Terminal Attack Controller (JTAC) training, to ensure the combat readiness of flying units throughout the Northeast and Mid-Atlantic region. Fighter and attack aircraft employ ordnance including bombs, bullets and rockets, which is inert only, to various scorable targets in the range (US Air Force 2018).

Bollen operates three military training routes, of varying altitude and terrain, which merge together at the entry of the range complex. Aircraft utilize the Special Use Airspace R-5802 A/B/C for bomb deliveries and R-5802 D/E airspace for high altitude bomb deliveries.

Noise generated by aerial gunnery training is confined to a relatively remote part of the range and/or FTIG impact area. Thus, the primary source of noise associated with the range is the aircraft operating within the airspace at low altitudes. Annual operations at the range are not high enough to generate a Noise Zone. Maximum sound levels are provided in Table 4-19 for the A-10 fixed-wing fighter aircraft, which is the primary user of the range, and the F-16 jet fighter aircraft, which is the loudest aircraft operating in the airspace.

Table 4-19. Maximum A-Weighted Sound Levels for Jet Fighter Aircraft

Slant Distance (Feet)	Maximum Sound Level , dBA <sup>1</sup>	
	A-10 200 kts	F-16 200 kts, 89% NC
250	102	123
500	95	117
1,000	87	106
1,500	82	102
2,000	78	98
2,500	75	92
5,000	65	65

<sup>1</sup> Obtained via SelCalc Program (U.S. Air Force 2005)

#### **4.6.4 UNMANNED AERIAL SYSTEM AIRCRAFT**

UAS operations at FTIG consist of the RQ-7 Shadow tactical reconnaissance, surveillance, target acquisition, and battle damage assessment aircraft. The Shadow UAS is launched from a trailer mounted pneumatic catapult and is recovered with the aid of arresting gear. There are numerous variants of the Shadow aircraft, however most share the same 38 horsepower rotary engine powerplant.

UAS launch and recovery at FTIG takes place at the UAS runway, located approximately one mile east of Muir AAF, inside TA A-16 (See Figure 4-11). Aircraft use the flight corridor in controlled Muir AAF airspace for ingress and egress to the R-5802, where all mission operations take place. Typical operating altitude for Shadow missions at FTIG ranges from 4,000-6,000 feet MSL (~3,000-5,000 feet AGL).

Based on mission frequency, altitudes and training locations used on FTIG, noise impacts from UAS operations on the surrounding land use is considered minimal. Once the RQ-7 Shadow aircraft reaches its mission altitude, annoyance potential from overflight is low. This is particularly true given the amount of larger rotary-wing aircraft operating in and around the same airspace on a daily basis.

## **5 ARMY AVIATION SUPPORT FACILITY # 2 - JOHNSTOWN**

### **5.1 GENERAL**

AASF #2 is collocated on the John Murtha Johnstown-Cambria County Airport, located three miles northeast of Johnstown in Cambria County. The airport is joint civilian-military public airport, owned by Johnstown-Cambria County Airport Authority. The airport is used for general aviation, including one commercial airline service (Southern Airways Express) offering daily commuter flights (flyjst.com). In addition to the PAARNG's 2<sup>nd</sup> Battalion, 104 Aviation Regiment (General Support Aviation), the airport is home several other military units including the PAANG 258<sup>th</sup> Air Traffic Control Squadron, the U.S. Marine Corps Marine Wing Support Squadron 471, and Detachment A, 4<sup>th</sup> Marine Aircraft Wing, of the U.S. Marine Corps Reserve.

### **5.2 AIRCRAFT NOISE**

The PAARNG operates twenty UH-60 Blackhawks at the Johnstown AASF, primarily Monday through Friday from 7:00am to 11:00pm, with occasional drill weekend flight activities. AASF personnel estimate six aircraft operate per day, with each aircraft flying two separate training missions. Aircraft return to the AASF to refuel before the second mission. Thus, on average, there are approximately two departures and two arrivals per aircraft per day. Nighttime operations comprise less than 20 percent. There are no specific flight corridors for rotary-wing aircraft entering and exiting the airspace at the airport. All closed traffic patterns are controlled by the Air Traffic Control Tower.

Johnstown-Cambria County Airport operational statistics kept by the FAA, (12-month period ending 31 December 2017) list the average daily flights at 55 per day. Approximately 42 percent are military, 47 percent are local and transient general aviation and 11 percent are commercial (airnav.com). The average number of daily operations and run-up activities from the AASF alone are not high enough to generate a cumulative (ADNL) Zone II. The land adjacent to the AASF #2, north and west of the airport boundary, is largely undeveloped forest lands and low-density residential uses, concentrated along Frankstown Road. The largest urban center in the area is Johnstown to the southwest, along with the smaller communities of Oakland and Geistown (Figure 5-1).

### **5.3 ANNOYANCE POTENTIAL FROM SINGLE OVERFLIGHT**

Although the AASF does not generate annual noise levels which would affect local land use outside the AASF, noise from individual UH-60 operations beyond the support facility has the potential to be disruptive and/or annoying. The LFA for AASF aircraft spans the western half of Pennsylvania and stretches as far west as Ohio and south to West Virginia. Within the LFA aircraft make use of other local airports and SGL areas for specific training missions, particularly SGL-51, located roughly 45 miles southwest of the AASF. The previous section listed singular overflight levels for the UH-60 (Table 4-14 and Table 4-17). Again, these distances and altitudes can be used to delineate new flight tracks or low level routes and to further avoid the overflight of noise-sensitive areas.



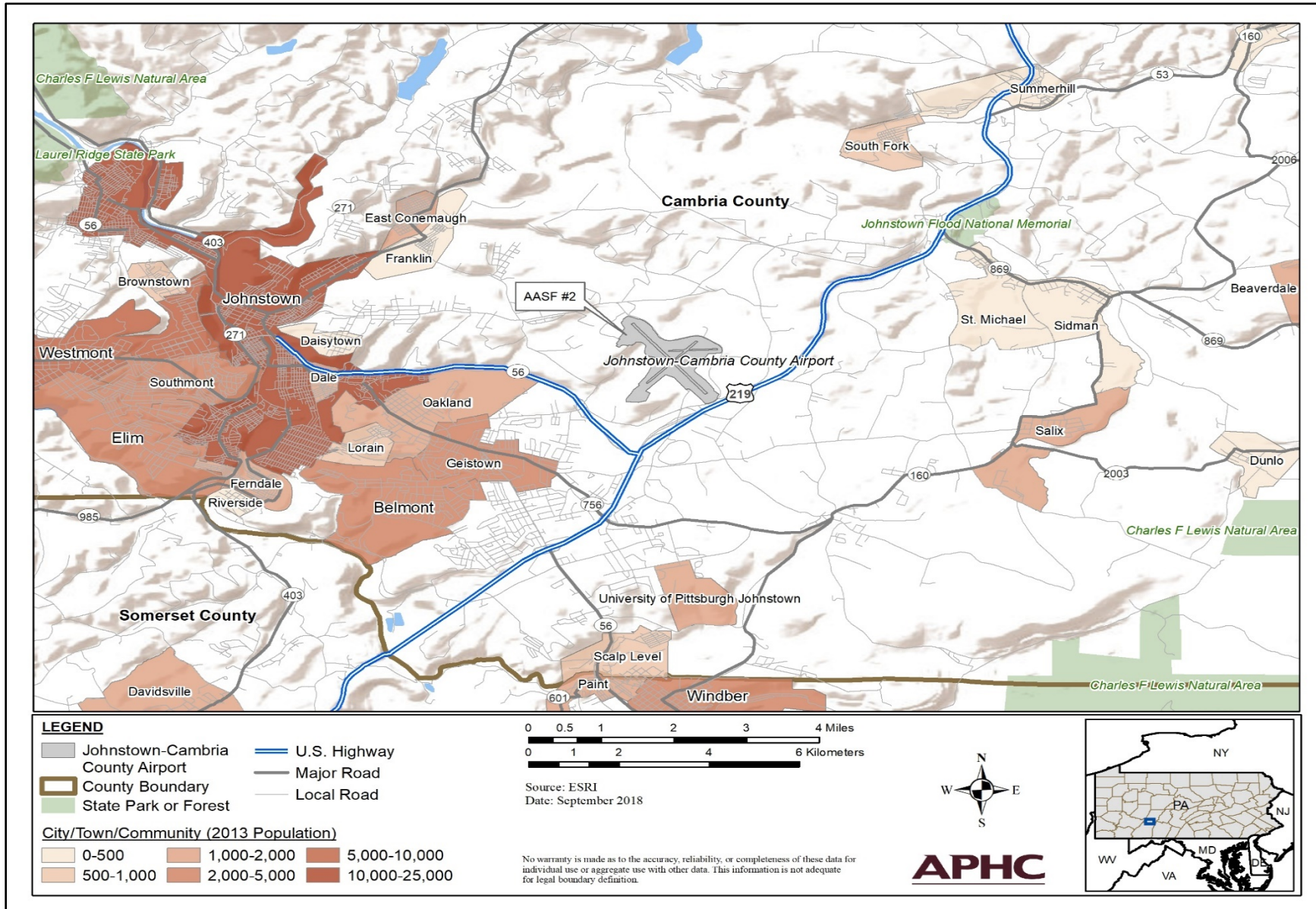


Figure 5-1. AASF #2 – Johnstown-Cambria County Airport General Location

## 6 NOISE RELATED LAND USE POLICY AND CONTROL

### 6.1 INTRODUCTION

Implementation of the ICUZ program is intended be a joint effort between PAARNG and the adjacent communities. The role of PAARNG is to minimize operational noise impacts on the surrounding local communities. The role of communities is to ensure that development in the surrounding area is compatible with accepted planning, zoning, and development principles and practices to protect the PAARNG mission.

### 6.2 ACHIEVING LAND USE COMPATIBILITY

Achieving land use compatibility requires both flexibility and creativity from land use planners, installation commanders, and the citizenry. The previous sections of this document detailed the environmental noise impacts. The following sections detail land use planning tools which are available to both the installation and local communities.

### 6.3 JOINT LAND USE STUDY (JLUS)

The JLUS is a collaborative land use planning effort involving the military installation and adjacent local governments that evaluate the planning rationale necessary to support and encourage compatible development of land surrounding the installation. It is a means for the installation and local governments to develop a plan that effectively addresses the long-term land use needs of the of the surrounding communities, yet still provides the military with the mission flexibility it needs to meet training doctrine.

The JLUS program is sponsored by the Department of Defense Office of Economic Adjustment (OEA) (DODI, 2004), which provides technical and financial assistance to the planning agencies for developing plans that are consistent, when economically feasible, with the noise, accident potential, and safety concerns from an installation's training and operations. The cost of the plan is shared between the OEA and the partners involved.

The scope of the program is divided into three major tasks:

1. Impact Analysis. Impact analysis provides an in-depth review of existing and proposed land use patterns; drainage (as it effects land use designations); mission encroachment; transportation improvements, existing and proposed routes; noise/vibration; and other compatibility issues deemed pertinent to JLUS partners.
2. Land Use and Mission Compatibility Plan. Examines the above findings to identify conflicts in land use and provide alternative land use solutions; to project the impact on growth potential for adjacent areas; and to project the impact of military missions on the surrounding jurisdictions.

3. Implementation. Lists a series of actions and/or recommendations for adoption by local jurisdictions to resolve land use conflicts and move toward a compatible land use plan for the installation, the adjacent counties and municipalities, and the communities therein.

While the study report makes certain recommendations, each participating jurisdiction must decide which recommendations are best suited to their particular needs. Implementation follows the final recommendations at the discretion of elected officials in each jurisdiction and the installation military command.

The Fort Indiantown Gap (FTIG) JLUS was completed in January 2015, with funding from OEA, Lebanon and Dauphin Counties. The study was a collaborative planning effort led by Lebanon County (Planning Department) in partnership with the townships of Union and East Hanover in Lebanon County; Dauphin County containing the townships of East Hanover and West Hanover; and FTIG. Representatives from the local government partners and FTIG were selected to serve on two committees (Executive and Technical) that provided policy direction and technical support, review and guidance of the study.

The primary JLUS study area was identified based on the area experiencing the most direct impacts, such as noise and proximity to flight safety zones associated with FTIG. Additionally, an indirect study area was identified as the general area within a three-mile radius from the installation perimeter to consider impacts on transportation systems and general coordination and communication amongst municipalities. The primary characteristics evaluated in determining the study area were compatibility factors associated with military mission readiness and land uses such as those producing noise and vibration, and /or dust and smoke, and those requiring infrastructure extensions (JLUS 2015).

The study produced four separate Military Compatibility Areas (MCA), one of which was a Noise MCA, along with Safety, Vertical Safety, and Light. The strategies developed are designed to address the issues identified for each MCA. The purpose of each strategy is to:

- avoid future actions, operations, or approvals that would cause a compatibility issue
- eliminate an existing compatibility issue
- reduce the adversity of an existing issue, and / or
- provide for on-going communications and collaboration

## 6.4 ARMY COMPATIBLE USE BUFFER (ACUB) PROGRAM

Along with the aforementioned Noise Zones, the Army has a specific program designed to limit the effects of encroachment. The ACUB program was borne out of a 2002 expansion of the Private Lands Initiative (10 USC §2684a) allowing military departments to partner with private organizations to establish conservation easements or buffer areas around active installations. These partnerships are beneficial in a number of ways:

- To FTIG:
  - Manages development adjacent to and near FTIG
  - Protects effective training space to the installation boundaries
  - Averts training restrictions
  - Mitigates against noise and smoke complaints
- To FTIG Community Partners:
  - Protects FTIG mission and strength, contributing to local economy
  - Does not remove lands from tax base
  - Maintains local agricultural and nature lands
- To Landowners:
  - Maintains current, compatible land uses
  - Provides cash in hand
  - Retain rights to ownership and management of land

FTIG began its official ACUB program in 2013, with the initial interest in protecting aviation training mission capabilities. Since that time the program goals have expanded to include live-fire range activities, including minimizing noise complaints and maximizing utilization of training facilities, while promoting land conservation and habitat protection.

FTIG’s primary partner, Ward Burton Wildlife Foundation, assists with the encumbrance of identified priority land parcels, via the use of conservation easements, fee-simple purchases, and other mechanisms with willing landowners. Figure 6-1 illustrates the programs four priority areas.

To date, the ACUB program has conserved a total of approximately 8,200 acres, with over \$12 million dollars in funding. A large part of this success is attributed to the DeHart Reservoir project. This project is a partnership between FTIG, Capital Region Water, the Ward Burton Wildlife Foundation, and The Nature Conservancy, which has protected approximately 8,100-acres of land around the DeHart Reservoir, a high-quality drinking water source, an important part of FTIG’s aviation training area, and one of the last large areas of unbroken forested habitat in the region. This project includes a conservation easement, forest management planning, and carbon offset components (FTIG 2018b).

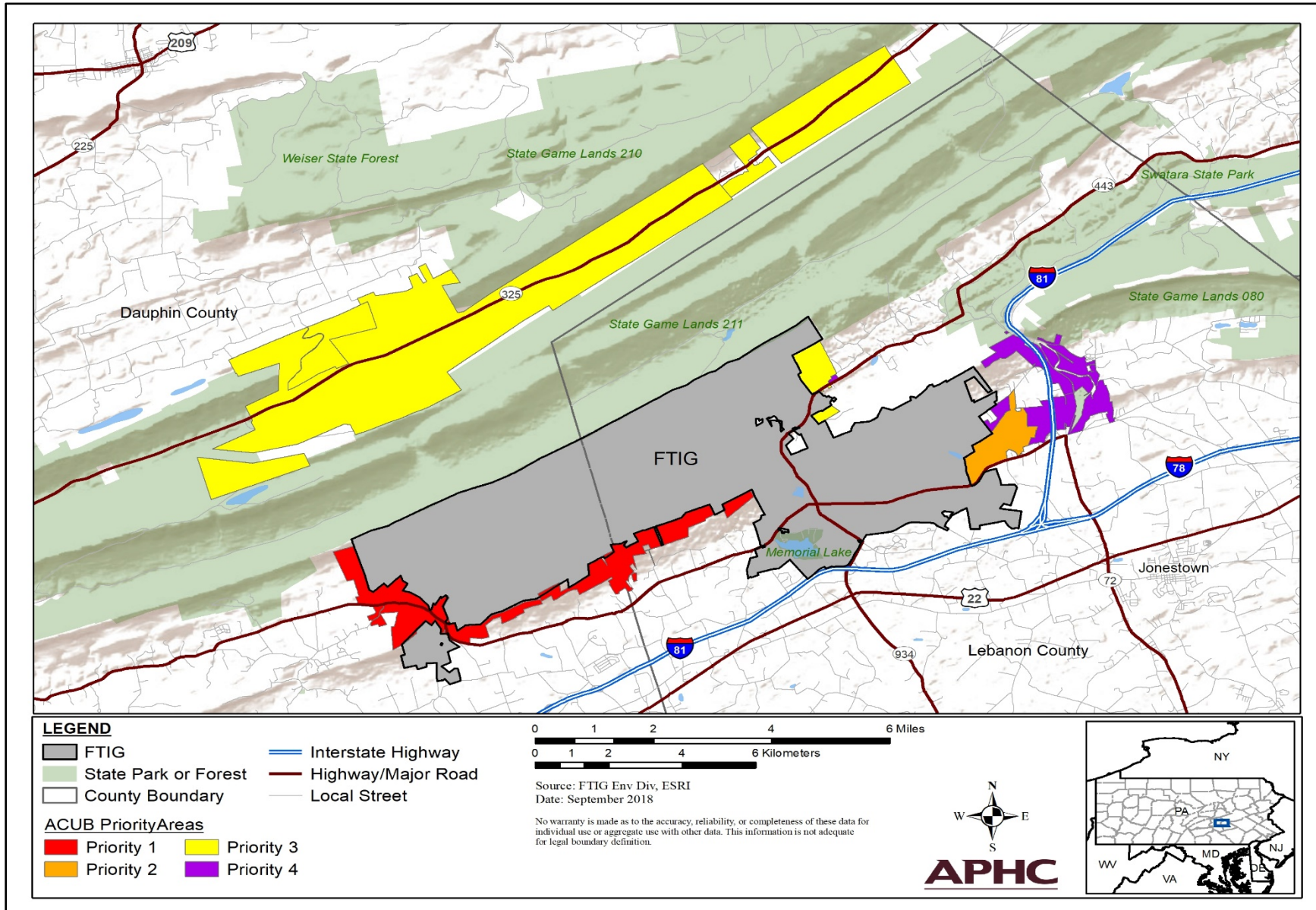


Figure 6-1. FTIG ACUB Priority Areas

## 6.5 LAND USE PLANNING OPTIONS

The following land use planning tools are available to help local governments create areas of compatible use around military installations. Many on the list are already in use; however, FTIG and local governments are strongly encouraged to revisit and/or update any of these options to find the equitable solutions that best work for their situation. These planning tools may be used individually or in combination.

Zoning. The most common method of land use control is *zoning*, or the partitioning of areas into sections reserved for different purposes. This method is an exercise of the police powers of state and local governments that designates the uses permitted in each parcel of land. It normally consists of a zoning ordinance that delineates the various use districts and a zoning map based on the land use element of the community's comprehensive general plan.

Easements. Easements can be an effective and permanent form of land use control; in many instances, better than zoning when trying to resolve an installation's compatibility issues. Easements are permanent (with the title held by the purchaser until sold or released), work equally well within different jurisdictions, are enforceable through civil courts, and may be acquired often at a fraction of the cost of the land value.

Subdivision Regulations. Subdivision regulations are a means by which local governments can ensure that proper lot layout, design, and improvements are included in new residential or commercial developments. These requirements may be anything from dictating the width of the roads to placement of the water and/or sewer systems. Since most local governments require some type of public dedication of open space when approving development plans, the installation may lobby to have a provision added to the subdivision regulations that requires this open space to be located nearest the installation boundary to create a buffer.

Disclosure of Noise Levels. Since noise levels in a community can be effectively modeled, as well as measured and recorded, making noise level information readily available can sometimes be all it takes to discourage incompatible land uses. These noise levels can be disclosed in several ways, including ordinances (or amendments to existing ordinances), deeds, posting noise levels on any sale/lease/rent sign, and initiating voluntary programs among local realtors to provide potential buyers with installation-provided information and noise level/contour mapping.

Deed Restrictions/Covenants. A deed is a document conveying ownership of land from one party to another, and restrictions called *covenants* can be added to the deed to specify restrictions on the use of the land. These covenants are on top of the restrictions already imposed by the current zoning of the property and in many instances may supersede zoning by prohibiting specified uses that would otherwise be allowed. Restrictive covenants "run with the land;" that is, no matter how often the land is resold, these covenants remain in effect until the specified length of the covenant has expired. In order to utilize this option, the installation must already own or must acquire the property. Then, when reselling the property, the installation specifies which uses are permitted on the land thereby preventing incompatible uses (such as residential housing) for as long as the restrictions remain in effect.

## 7 SUMMARY

The primary focus of the ICUZ study is to quantify the noise environment from military training sources and define the most appropriate uses of noise-impacted areas. The principle noise sources at PAARNG training facilities are small and large caliber weapons firing, including demolitions, and aircraft training.

### 7.1 FTIG SMALL ARMS WEAPONS

#### Small Arms Ranges

The Noise Zones from small arms firing are generally contained to training lands on post; however, Zone II does extend off post in several areas, most prominently along the western boundary. Zone III also extends just beyond the west boundary. The terrain features along the north and south boundary of the training corridor provide significant attenuation of sound from live-fire activities in this area. Land use within Zone II off post is primarily forest land, with some pasture and agricultural lands. Single-family residences are contained within the Zone II areas east and south of the boundary, with the largest concentration of residential land use occurring west of FTIG. The areas north are uninhabited State Game Lands. Zone III beyond the west boundary does not contain any noise-sensitive land use.

On post, Zone II and Zone III extend into the cantonment area from firing at the range complex, encompassing enlisted barracks and family housing on the west end of the cantonment. Zone III does not contain any noise-sensitive land uses.

#### Non-Fixed Firing Ranges

Training activities which require the firing of small arms weapons using blank ammunition occur in multiple collective training facilities in the central portion of the Fort. Maneuver training areas also support these operations at FTIG. In most cases, weapons fire takes place far enough from the installation boundary that noise impacts would be minimal.

### 7.2 FTIG LARGE CALIBER WEAPONS AND EXPLOSIVES

#### Land Use Compatibility

The cumulative large caliber and demolition operations Noise Zones show impacts to sensitive land uses are generally limited to the areas northeast and west of the installation boundary. As was the case with small arms firing, the Mountain ranges along the north and south boundary of FTIG provide significant attenuation of large caliber noise. Land use within the Zone II off post is primarily forest and agricultural lands, with some low-density residential. There are no noise-sensitive land uses contained within Zone III.

The largest number of sensitive land uses occurs within the LUPZ, which extends beyond the boundary east and west, into the valley, and just along the south boundary. Noise-sensitive land use within the LUPZ is considered compatible per Army guidelines; however, the LUPZ is delineated to indicate areas of emphasis for land use planners. These areas, although below Zone II limits, represent noise levels that some communities may still find unacceptable.

On post, the Noise Zones extend south into a localized area of the cantonment. Zone II contains several enlisted barracks and family housing adjacent to the airfield, as well as several homes located inside the inholdings on the east end of the training corridor. Zone III does not contain any sensitive land use.

#### Single Event Levels

Under unfavorable weather, peak sound levels between 115 and 130 dB extend beyond the boundary in all directions, but to the greatest degree east and west. Residential land use in these areas is common. The 115-130 dB noise contour also extends south of the cantonment as far as Interstate 81. The land in this area is comprised primarily of Fort Indiantown Gap National Cemetery.

Peak sound levels above 130 dB extend beyond the boundary northeast, west, and one area south. There are no sensitive land uses contained within these areas. However, there are multiple single-family homes just beyond the contour northeast and along the southwest boundary. Thus, during weather that favors propagation, these homes may receive a greater-than-normal noise dose from large caliber weapons training.

On post, peak sound levels between 115 and 130 dB envelope the majority of the cantonment, along with Memorial Lake State Park, and homes within the inholding area north of the state park. Peak sound levels above 130 dB within the cantonment contain multiple troop barracks and family housing buildings. In addition, two inholding areas containing several occupied homes are contained within the 130 dB contour in the east end of the main training corridor.

Under neutral weather conditions, peak sound levels diminish considerably, particularly along the eastern and southern boundaries. Noise impacts to sensitive land use are generally limited to the area southwest, where scattered residential properties exist. Peak sound levels above 130 dB extend beyond the installation boundary in one small area northeast, and one area south. There are no sensitive land uses contained in either of these areas.

On post, sound levels between 115 and 130 dB once again extend south into the cantonment, encompassing troop barracks and some family housing structures. Inholding areas on the east end of the main training corridor also included in the 115-130 dB contour. Peak sound levels above 130 dB in the cantonment are primarily confined to the airfield which does not contain any sensitive land use.

### **7.3 FTIG AVIATION ACTIVITY**

#### Muir Army Airfield – AASF #1

The cumulative Noise Zones from operations at Muir Army Airfield show the greatest impacts to sensitive land use off post are east of the installation boundary. Zone II extends beyond the boundary east and south of the main cantonment. Land use is a mix of agricultural, forest, commercial, and residential. Land use in the area south is primarily national cemetery lands. Zone III does not extend beyond the FTIG boundary.



On post, the Noise Zones encompass the majority of the cantonment area. Sensitive land use within Zone II is generally troop barracks and family housing. Zone III extending west primarily contains compatible land use, with the exception of several non-military housing structures on Clement Avenue.

Unmanned Aerial Systems

Unmanned Aerial System (UAS) launch and recovery operations take place at FTIG using the RQ-7 Shadow UAS aircraft. Training flight missions take place within the restricted airspace R-5802 at FTIG. Generally, the noise produced from UAS activities within the shared airspace is considerably quieter than other larger aircraft activities. Once UAS aircraft reach mission altitudes the annoyance potential from overflight is low.

Aircraft Single Overflight

Aircraft operating outside of the airfield and/or support facility, within a designated low-level flight track, aviation training area, maintenance test flight area, or transitioning within the local flying area all have the potential to cause annoyance and possibly generate noise complaints from single overflight. This also includes fixed-wing aircraft making use of the Bollen Air-to-Ground Range and Drop Zones at FTIG. Noise abatement measures are currently in place to help mitigate the effects of aircraft noise, including minimum flight altitudes and procedures to avoid residential overflight.

**7.4 ARMY AVIATION SUPPORT FACILITY #2**

AASF #2 – Johnstown-Cambria County Airport

Annual rotary-wing operations at the AASF #2, although steady, are not high enough to generate a Zone II or Zone III which extends beyond the airport boundary. In addition, the AASF is collocated at a joint military and civilian airport, where several other noise-producing aircraft, including military rotary-wing and civilian fixed-wing general aviation operations take place daily. Nevertheless, individual flights departing and arriving at the support facility or operating within the local flying area have the potential to cause annoyance and produce noise complaints.

**7.5 RECOMMENDATIONS**

The ICUZ is a proactive planning tool, which can help guide future development in surrounding communities. At a minimum, local municipal governments are encouraged to support public disclosure of all Noise Zones and supplemental metrics which may convey how military training operations affect the noise environment.

The ICUZ study describes the noise characteristics of a specific operational environment, and as such, will change if a significant operational change is made. Therefore, if PAARNG’s training entities, particularly the mission, training, or training facilities at FTIG undergo changes, the ICUZ should be reviewed to determine if the current noise assessment is sufficient. At a minimum, it is recommended that every five years the ICUZ and/or Noise Zones be updated to incorporate pertinent changes to the noise environment.

## A GLOSSARY OF TERMS

**A-Weighted Sound Level** – a sound level (in decibels) that has been weighted to correspond with the non-linear sensitivity of the human ear. A-weighting discriminates against the lower frequencies and is used to measure most common military sounds such as transportation and small-arms fire.

**Ambient Noise** – the background noise that is usually present at a particular location; anything from cars on a highway, to insects in the woods.

**Atmospheric Refraction** – the bending and/or focusing of sound waves by the varying layers and densities of the earth’s atmosphere.

**C-Weighted Sound Level** – like A-weighting, this is another sound level weighting technique that is used to normalize the low, impulsive sounds to the range of human hearing. It is used when measuring low frequency sound such as those from large arms, demolitions, and sonic booms.

**Day-Night Average Sound Level (DNL)** – the 24-hour average frequency-weighted sound level, in decibels, from midnight to midnight, obtained after the addition of 10 decibel “penalties” to sound levels between midnight and 7 a.m. and 10 p.m. to midnight (0000 to 0700 hours and 2200 to 2400 hours). A-weighting (ADNL) is understood unless otherwise specified, but C-weighting (CDNL) is also common.

**Decibels (dB)** – a logarithmic sound pressure unit of measure.

**Equivalent Sound Level (LEQ)** – the level of a constant sound which, in a given situation and time period, has the same energy as does a time varying sound. For noise sources which are not in continuous operation, the equivalent sound level may be obtained by summing individual sound exposure level (SEL) values and normalizing them over the appropriate time period.

**Frequency** – the number of complete oscillation cycles per unit of time. The unit of frequency is the Hertz.

**Frequency Weighting** – the process of factoring in certain frequencies more or less heavily in order to bring the sound measurement more in line with the characteristics of the receiver (and thus make the numbers more meaningful to the task at hand). Example: A- or C-weighting to specifically parallel the sensitivity of the human ear.

**Hertz** – the unit of frequency equal to once cycle per second.

**Impulse (or Impulsive) Noise** – noise of short duration (typically less than one second), high intensity, abrupt onset and rapid decay, and often rapidly changing spectral composition. Impulsive noise is characteristically associated with such sources as explosions, impacts, the

discharge of firearms, the passage of supersonic aircraft (creating sonic booms), and many industrial processes.

**Land Use Planning Zone (LUPZ)** – The Land Use Planning Zone (LUPZ) is a subdivision of Zone I. The LUPZ is 5 dB lower than the Zone II.

**Large Caliber/Arms** – conventional military weapons over 20 millimeters in diameter.

**Noise** – any sound without value or unwanted sound.

**Noise Level Reduction** – the difference, in decibels, between the sound level outside a building and the sound level inside a designated room in the building (usually A-weighted). The NLR is dependent upon the transmission loss characteristics of the building surfaces exposed to an exterior noise source, the particular noise characteristics of the exterior noise source, and the acoustic properties of the designated room in the building.

**Noise Zone III** – the area around a noise source in which the C-weighted day-night sound level (CDNL) is greater than 70 dB (demolition and large caliber weapons), the A-weighted day-night level (ADNL) is greater than 75 dB (aviation), or the dB Peak is greater than 104 (small caliber weapons).

**Noise Zone II** – the area around a noise source in which the CDNL is 62-70 dB (demolition and large caliber weapons), the ADNL is 65-75 dB (aviation), or the dB Peak is 87-104 (small caliber weapons).

**Noise Zone I** – included all areas around a noise source in which the CDNL is less than 62 dB (demolition and large caliber weapons), the ADNL is less than 65 dB (aviation), or the dB Peak is less than 87 (small caliber weapons). This area is usually suited for all types of land use activities.

**Peak** – Peak is a single-event sound level without weighting.

**PK15(Met)** – PK15(met) is a computer modeled single-event peak level that is exceeded only 15 percent of the time by the loudest munitions type detonation. This metric accounts for variations caused by weather conditions and favors noise propagation. The PK15(met) metric does not communicate any information about how often the loudest munitions type is detonated.

**PK50(Met)** - is similar to the PK15(met) except that it represents the peak noise level that is exceeded 50 percent of the time. This metric also accounts for weather but assumes conditions which are not favorable for noise propagation.

**Propagation** – the process by which sound travels through space or material; may be affected by such things as weather, terrain, and barriers.

**Slant Distance** – the straight-line distance between two points not at the same elevation as contrasted with ground distance. Also known as slant range.

**Small Arms** – conventional military weapons .50 caliber and below in diameter.

**Sound Exposure Level (SEL)** – the total energy of a sound event normalized to a specific amount of time (e.g., one second) so that sounds of different durations may be compared directly.

**Unweighted Peak Sound Level** – the peak, single event sound level without weighting, without taking into account berms or other attenuation, and without any particular certainty.

## **B LAND USE GUIDELINES**

Land use recommendations vary based on the type of noise source. The Federal Interagency Committee on Urban Noise (FICUN, 1980) guidelines in Table B-1 are applicable to A-weighted noise sources such as aircraft and traffic. Using the FICUN guidelines, the Army in conjunction with recommendations of the National Academy of Sciences Committee on Hearing, Bioacoustics and Biomechanics (CHABA 1981), developed Noise Zone limits for weapons and explosive noise. Tables B-2 and B-3 contain land use recommendations for land within the weapons and explosive Noise Zones.

TABLE B-1. FICUN GUIDELINES

SLUCM No.	LAND USE	NOISE ZONES AND ADNL LEVELS (dBA)						
		Noise Zone I		Noise Zone II		Noise Zone III		85+
		0-55	55-65	65-70	70-75	75-80	80-85	
<b>10</b>	<b>Residential</b>							
11	Household Units	Yes	Yes*	25 <sup>1</sup>	30 <sup>1</sup>	No	No	No
12	Group Quarters	Yes	Yes*	25 <sup>1</sup>	30 <sup>1</sup>	No	No	No
13	Residential Hotels	Yes	Yes*	25 <sup>1</sup>	30 <sup>1</sup>	No	No	No
14	Mobile Home Parks or Courts	Yes	Yes*	No	No	No	No	No
15	Transient Lodgings	Yes	Yes*	25 <sup>1</sup>	30 <sup>1</sup>	35 <sup>1</sup>	No	No
16	Other Residential	Yes	Yes*	25 <sup>1</sup>	30 <sup>1</sup>	No	No	No
<b>20, 30</b>	<b>Manufacturing</b>							
21	Food & Kindred Products	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
22	Textile Mill Products	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
23	Apparel/Other Finished Products	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
24	Lumber & Wood Products	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
25	Furniture & Fixtures	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
26	Paper & Allied Products	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
27	Printing, Publishing & Allied Products	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
28	Chemicals & Allied Products	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
29	Petroleum Refining & Related Industries	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
31	Rubber & Misc Plastic Products - Manufacturing	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
32	Stone, Clay & Glass Products Manufacturing	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
33	Primary Metal Industries	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
34	Fabricated Metal Products - Manufacturing	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
25	Professional, Scientific & Controls	Yes	Yes	Yes	25	30	No	No
39	Miscellaneous Manufacturing	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
<b>40</b>	<b>Transportation Communication &amp; Utilities</b>							
41	Railroad, Rapid Rail Transit & Street Rail	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	Yes <sup>4</sup>
42	Motor Vehicle Transportation	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	Yes <sup>4</sup>
43	Aircraft Transportation	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	Yes <sup>4</sup>
44	Marine Craft Transportation	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	Yes <sup>4</sup>
45	Highway & Street Right-of-Way	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	Yes <sup>4</sup>
46	Automobile Parking	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
47	Communications	Yes	Yes	Yes	25 <sup>5</sup>	30 <sup>5</sup>	No	No
48	Utilities	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	Yes <sup>4</sup>
49	Other Transportation, Communication & Utilities	Yes	Yes	Yes	25 <sup>5</sup>	30 <sup>5</sup>	No	No

TABLE B-1. FICUN GUIDELINES, cont'd

SLUCM No.	LAND USE	NOISE ZONES AND ADNL LEVELS (dBA)						
		Noise Zone I		Noise Zone II		Noise Zone III		85+
		0-55	55-65	65-70	70-75	75-80	80-85	
<b>50</b>	<b>Trade</b>							
51	Wholesale Trade	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
52	Retail - Building Materials, Hardware/Farm	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
53	Retail - General Merchandise	Yes	Yes	Yes	25	30	No	No
54	Retail - Food	Yes	Yes	Yes	25	30	No	No
55	Retail - Auto, Marine, Aircraft & Parts	Yes	Yes	Yes	25	30	No	No
56	Retail - Apparel & Accessories	Yes	Yes	Yes	25	30	No	No
57	Retail - Furniture, Furnishings & Equipment	Yes	Yes	Yes	25	30	No	No
58	Retail - Eating & Drinking Facilities	Yes	Yes	Yes	25	30	No	No
59	Other Retail Trade	Yes	Yes	Yes	25	30	No	No
<b>60</b>	<b>Services</b>							
61	Finance, Insurance & Real Estate Services	Yes	Yes	Yes	25	30	No	No
62	Personal Services	Yes	Yes	Yes	25	30	No	No
62.4	Cemeteries	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	Yes <sup>6</sup>
63	Business Services	Yes	Yes	Yes	25	30	No	No
64	Repair Services	Yes	Yes	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	No
65	Professional Services	Yes	Yes	Yes	25	30	No	No
65.1	Hospitals, Nursing Homes	Yes	Yes*	25*	30*	No	No	No
65.1	Other Medical Facilities	Yes	Yes	Yes	25	30	No	No
66	Contract Construction Services	Yes	Yes	Yes	25	30	No	No
67	Government Services	Yes	Yes*	Yes*	25*	30*	No	No
68	Educational Services	Yes	Yes*	25*	30*	No	No	No
69	Miscellaneous Services	Yes	Yes	Yes	25	30	No	No
<b>70</b>	<b>Cultural Entertainment &amp; Recreational</b>							
71	Cultural Activities, Including Churches	Yes	Yes*	25*	30*	No	No	No
71.2	Nature Exhibits	Yes	Yes*	Yes*	No	No	No	No
72	Public Assembly	Yes	Yes	Yes	No	No	No	No
72.1	Auditoriums, Concert Halls	Yes	Yes	25	30	No	No	No
72.11	Outdoor Music Shells, Amphitheaters	Yes	Yes*	No	No	No	No	No
72.2	Outdoor Sports Arenas, Spectator Sports	Yes	Yes	Yes <sup>7</sup>	Yes <sup>7</sup>	No	No	No
73	Amusements	Yes	Yes	Yes	Yes	No	No	No
74	Recreational Activities	Yes	Yes*	Yes*	25*	30*	No	No
75	Resorts, Groups & Camps	Yes	Yes*	Yes*	Yes*	No	No	No
76	Parks	Yes	Yes*	Yes*	Yes*	No	No	No
79	Other Cultural, Entertainment & Recreation	Yes	Yes*	Yes*	Yes*	No	No	No

TABLE B-1. FICUN GUIDELINES, cont'd

SLUCM No.	LAND USE	NOISE ZONES AND ADNL LEVELS (dBA)						
		Noise Zone I		Noise Zone II		Noise Zone III		
		0-55	55-65	65-70	70-75	75-80	80-85	85+
<b>80</b>	<b>Resource Product &amp; Extract</b>							
81	Agriculture (Except Livestock) <sup>11</sup>	Yes	Yes	Yes <sup>8</sup>	Yes <sup>9</sup>	Yes <sup>10</sup>	Yes <sup>10</sup>	Yes <sup>10</sup>
81.5 to 81.7	Livestock Framing & Animal Breeding	Yes	Yes	Yes <sup>8</sup>	Yes <sup>9</sup>	No	No	No
82	Agricultural Related Activities	Yes	Yes	Yes <sup>8</sup>	Yes <sup>9</sup>	Yes <sup>10</sup>	Yes <sup>10</sup>	Yes <sup>10</sup>
83	Forestry Activities & Related Services	Yes	Yes	Yes <sup>8</sup>	Yes <sup>9</sup>	Yes <sup>10</sup>	Yes <sup>10</sup>	Yes <sup>10</sup>
84	Fishing Activities & Related Services	Yes	Yes	Yes	Yes	Yes	Yes	Yes
85	Mining Activities & Related Services	Yes	Yes	Yes	Yes	Yes	Yes	Yes
89	Other Resource Production & Extraction	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:

- SLCUM      Standard Land Use Coding Manual
- Yes        Land use and related structures compatible without restrictions.
- No         Land use and related structures are not compatible and should be prohibited.
- ADNL      A-weighted day-night sound level
- Yes<sup>x</sup>      “Yes” but with restrictions. Land use and related structures generally compatible; see footnotes.
- 25, 30, 35      Land use and related structures generally compatible; measures to achieve noise level reduction (NLR) of 25, 30 or 35 must be incorporated into design and construction of structure.
- 25\*, 30\*, 35\*      Land use generally compatible with NLR; however, measures to achieve an overall NLR do not necessarily solve noise difficulties and additional evaluation is warranted.
- NLR        Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.



Footnotes:

- \* The designation of these uses as "compatible" in this zone reflects individual Federal agencies' consideration of general cost and feasibility factors as well as past community experiences and program objectives. Localities, when evaluating the application of these guidelines to specific situations, may have different concerns or goals to consider.
  - a) Although local conditions may require residential use, it is discouraged in 65-70 ADNL and strongly discouraged in 70-75 ADNL. The absence of viable alternative development options should be determined and an evaluation indicating that a demonstrated community need for residential use would not be met if development were prohibited in these zones should be conducted prior to approval.
  - b) Where the community determines that residential uses must be allowed, measures to achieve outdoor to indoor NLR of at least 25 dB (65-70 ADNL) and 30 dB (70-75 ADNL) should be incorporated into building codes and be considered in individual approvals. Normal 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 and closed windows year round. Additional consideration should be given to modifying NLR levels based on peak noise levels.
  - c) 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 transportation sources. Measures that reduce noise at a site should be used wherever practical in preference to measures that only protect interior spaces.
- x<sup>2</sup> 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.
- x<sup>3</sup> 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 normal noise level is low.
- x<sup>4</sup> 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.
- x<sup>5</sup> If noise-sensitive, use indicated NLR; if not, use is compatible.
- x<sup>6</sup> No buildings.
- x<sup>7</sup> Land use compatible provided special sound reinforcement systems are installed.
- x<sup>8</sup> Residential buildings require a NLR of 25.
- x<sup>9</sup> Residential buildings require a NLR of 30.
- x<sup>10</sup> Residential buildings not permitted.
- x<sup>11</sup> In areas with ADNL greater than 80, land use not recommended, but if community decides use is necessary, hearing protection devices should be worn by personnel.

TABLE B-2. LAND USE COMPATIBILITY FOR SMALL ARMS NOISE

LAND USE		SUGGESTED LAND USE COMPATIBILITY	
SLUCM NO.	LAND USE NAME	Noise Zone II 87-104 dBP	Noise Zone III >104 dBP
10	Residential		
11	Household units	N <sup>1</sup>	N
11.11	Single units: detached	N <sup>1</sup>	N
11.12	Single units: semidetached	N <sup>1</sup>	N
11.13	Single units: attached row	N <sup>1</sup>	N
11.21	Two units: side-by-side	N <sup>1</sup>	N
11.22	Two units: one above the other	N <sup>1</sup>	N
11.31	Apartments: walk-up	N <sup>1</sup>	N
11.32	Apartment: elevator	N <sup>1</sup>	N
12	Group quarters	N <sup>1</sup>	N
13	Residential hotels	N <sup>1</sup>	N
14	Mobile home parks or courts	N <sup>1</sup>	N
15	Transient lodgings	25	N
16	Other residential	N <sup>1</sup>	N
20	Manufacturing		
21	Food and kindred products; manufacturing	Y <sup>2</sup>	Y <sup>3</sup>
22	Textile mill products; manufacturing	Y <sup>2</sup>	Y <sup>3</sup>
23	Apparel and other finished products; products made from fabrics, leather, and similar materials; manufacturing	Y <sup>2</sup>	Y <sup>3</sup>
24	Lumber and wood products (except furniture); manufacturing	Y <sup>2</sup>	Y <sup>3</sup>
25	Furniture and fixtures; manufacturing	Y <sup>2</sup>	Y <sup>3</sup>
26	Paper and allied products; manufacturing	Y <sup>2</sup>	Y <sup>3</sup>
27	Printing, publishing, and allied industries	Y <sup>2</sup>	Y <sup>3</sup>
28	Chemicals and allied products; manufacturing	Y <sup>2</sup>	Y <sup>3</sup>
29	Petroleum refining and related industries	Y <sup>2</sup>	Y <sup>3</sup>
30	Manufacturing (continued)		
31	Rubber and misc. plastic products; manufacturing	Y <sup>2</sup>	Y <sup>3</sup>
32	Stone, clay and glass products; manufacturing	Y <sup>2</sup>	Y <sup>3</sup>
33	Primary metal products; manufacturing	Y <sup>2</sup>	Y <sup>3</sup>
34	Fabricated metal products; manufacturing	Y <sup>2</sup>	Y <sup>3</sup>
35	Professional scientific, and controlling instruments; photographic and optical goods; watches and clocks	25	35
39	Miscellaneous manufacturing	Y <sup>2</sup>	Y <sup>3</sup>
40	Transportation, communication and utilities		
41	Railroad, rapid rail transit, and street railway transportation	Y <sup>2</sup>	Y <sup>3</sup>
42	Motor vehicle transportation	Y <sup>2</sup>	Y <sup>3</sup>
43	Aircraft transportation	Y <sup>2</sup>	Y <sup>3</sup>
44	Marine craft transportation	Y <sup>2</sup>	Y <sup>3</sup>
45	Highway and street right-of-way	Y <sup>2</sup>	Y <sup>3</sup>
46	Automobile parking	Y <sup>2</sup>	Y <sup>3</sup>
47	Communication	25	35
48	Utilities	Y <sup>2</sup>	Y
49	Other transportation, communication and utilities	25	35

TABLE B-2. LAND USE COMPATIBILITY FOR SMALL ARMS NOISE, cont'd

LAND USE		SUGGESTED LAND USE COMPATIBILITY	
SLUCM NO.	LAND USE NAME	Noise Zone II 87-104 dBP	Noise Zone III >104 dBP
50	Trade		
51	Wholesale trade	Y <sup>2</sup>	Y <sup>3</sup>
52	Retail trade – building materials, hardware and farm equipment	25	35
53	Retail trade – including shopping centers, discount clubs, home improvement stores, electronics superstores, etc.	25	35
54	Retail trade – food	25	35
55	Retail trade – automotive, marine craft, aircraft and accessories	25	35
56	Retail trade – apparel and accessories	25	35
57	Retail trade – furniture, home, furnishings and equipment	25	35
58	Retail trade – eating and drinking establishments	25	35
59	Other retail trade	25	35
60	Services		
61	Finance, insurance and real estate services	25	35
62	Personal services	25	35
62.4	Cemeteries	Y <sup>2</sup>	Y <sup>3</sup>
63	Business services	25	35
63.7	Warehousing and storage	Y <sup>2</sup>	Y <sup>3</sup>
64	Repair services	Y <sup>2</sup>	Y <sup>3</sup>
65	Professional services	25	N
65.1	Hospitals, other medical facilities	N	N
65.16	Nursing homes	N	N
66	Contract construction services	25	35
67	Government services	25	35
68	Educational services	35	N
68.1	Child care services, child development centers, and nurseries	35	N
69	Miscellaneous		
69.1	Religious activities	35	N
70	Cultural, entertainment and recreational		
71	Cultural activities (& churches)	35	N
71.2	Nature exhibits	N	N
72	Public assembly	N	N
72.1	Auditoriums, concert halls	35	N
72.11	Outdoor music shells, amphitheaters	N	N
72.2	Outdoor sports arenas, spectator sports	N	N
73	Amusements	Y	N
74	Recreational activities (including golf courses, riding stables, water recreation)	N	N
75	Resorts and group camps	N	N
76	Parks	N	N
79	Other cultural, entertainment and recreation	N	N

TABLE B-2. LAND USE COMPATIBILITY FOR SMALL ARMS NOISE, cont'd

LAND USE		SUGGESTED LAND USE COMPATIBILITY	
SLUCM NO.	LAND USE NAME	Noise Zone II 87-104 dBP	Noise Zone III >104 dBP
80	Resource production and extraction		
81	Agriculture (except live- stock)	Y <sup>4</sup>	Y <sup>5</sup>
81.5	Livestock farming	Y <sup>4</sup>	N
81.7	Animal breeding	Y <sup>4</sup>	N
82	Agriculture related activities	Y <sup>4</sup>	Y <sup>5</sup>
83	Forestry activities	Y <sup>4</sup>	Y <sup>5</sup>
84	Fishing activities	Y	Y
85	Mining activities	Y	Y
89	Other resource production or extraction	Y	Y

Notes:

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

dBP- unweighted Peak decibel level

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<sup>x</sup> – Yes with restrictions. The land use and related structures generally are compatible. However, see note(s) indicated by the superscript.

N<sup>x</sup> – No with exceptions. The land use and related structures are generally incompatible. However, see note(s) indicated by the superscript.

25, 30, or 35 – The numbers refer to noise level reduction (NLR) levels. NLR (outdoor to indoor) is achieved through the incorporation of noise attenuation into the design and construction of a structure. Land use and related

Note 1:

a. Although local requirements for on- or off-base housing may require noise-sensitive land uses within Noise Zone II, such land use is generally not recommended. 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. Existing residential development is considered as pre-existing, non-conforming land uses.

b. Where the community determines that these uses must be allowed, measures to achieve outdoor to indoor NLR of at least 30 decibels (dB) in Noise Zone II should be incorporated into building codes and be considered in individual approvals.

c. Normal permanent construction can be expected to provide an NLR of 20 dB, thus the reduction requirements are often stated as 10 dB over standard construction and normally assume mechanical ventilation, upgraded sound transmission class ratings in windows and doors, and closed windows year round.

d. NLR criteria will not eliminate outdoor noise problems. However, building location, 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.

Note 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.

Note 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 normal noise level is low.

Note 4. Residential buildings require an NLR of 30.

Note 5. Residential buildings are not permitted.

TABLE B-3. LAND USE COMPATIBILITY: DEMOLITION AND LARGE ARMS NOISE

LAND USE		SUGGESTED LAND USE COMPATIBILITY		
SLUCM NO.	LAND USE NAME	LUPZ CDNL or CNEL 57-62	Noise Zone II CDNL or CNEL 62-70	Noise Zone III CDNL or CNEL 70+
10	Residential	Y <sup>1</sup>	N <sup>2,3</sup>	N <sup>3</sup>
11	Household units	Y <sup>1</sup>	N <sup>2,3</sup>	N <sup>3</sup>
11.11	Single units: detached	Y <sup>1</sup>	N <sup>2,3</sup>	N <sup>3</sup>
11.12	Single units: semidetached	Y <sup>1</sup>	N <sup>2,3</sup>	N <sup>3</sup>
11.13	Single units: attached row	Y <sup>1</sup>	N <sup>2,3</sup>	N <sup>3</sup>
11.21	Two units: side-by-side	Y <sup>1</sup>	N <sup>2,3</sup>	N <sup>3</sup>
11.22	Two units: one above the other	Y <sup>1</sup>	N <sup>2,3</sup>	N <sup>3</sup>
11.31	Apartments: walk-up	Y <sup>1</sup>	N <sup>2,3</sup>	N <sup>3</sup>
11.32	Apartment: elevator	Y <sup>1</sup>	N <sup>2,3</sup>	N <sup>3</sup>
12	Group quarters	Y <sup>1</sup>	N <sup>2,3</sup>	N <sup>3</sup>
13	Residential hotels	Y <sup>1</sup>	N <sup>2,3</sup>	N <sup>3</sup>
14	Mobile home parks or courts	Y <sup>1</sup>	N <sup>2,3</sup>	N <sup>3</sup>
15	Transient lodgings	Y	Y	N
16	Other residential	Y <sup>1</sup>	N <sup>2,3</sup>	N <sup>3</sup>
20	Manufacturing			
21	Food and kindred products; manufacturing	Y	Y <sup>4</sup>	Y <sup>4</sup>
22	Textile mill products; manufacturing	Y	Y <sup>4</sup>	Y <sup>4</sup>
23	Apparel and other finished products; products made from fabrics, leather, and similar materials; manufacturing	Y	Y <sup>4</sup>	Y <sup>4</sup>
24	Lumber and wood products (except furniture); manufacturing	Y	Y <sup>4</sup>	Y <sup>4</sup>
25	Furniture and fixtures; manufacturing	Y	Y <sup>4</sup>	Y <sup>4</sup>
26	Paper and allied products; manufacturing	Y	Y <sup>4</sup>	Y <sup>4</sup>
27	Printing, publishing, and allied industries	Y	Y <sup>4</sup>	Y <sup>4</sup>
28	Chemicals and allied products; manufacturing	Y	Y <sup>4</sup>	Y <sup>4</sup>
29	Petroleum refining and related industries	Y	Y <sup>4</sup>	Y <sup>4</sup>
30	Manufacturing (continued)			
31	Rubber and misc. plastic products; manufacturing	Y	Y <sup>4</sup>	Y <sup>4</sup>
32	Stone, clay and glass products; manufacturing	Y	Y <sup>4</sup>	Y <sup>4</sup>
33	Primary metal products; manufacturing	Y	Y <sup>4</sup>	Y <sup>4</sup>
34	Fabricated metal products; manufacturing	Y	Y <sup>4</sup>	Y <sup>4</sup>
35	Professional scientific, and controlling instruments; photographic and optical goods; watches and clocks	Y	N	N
39	Miscellaneous manufacturing	Y	Y <sup>4</sup>	Y <sup>4</sup>

TABLE B-3. LAND USE COMPATIBILITY: DEMOLITION AND LARGE ARMS NOISE, cont'd

LAND USE		SUGGESTED LAND USE COMPATIBILITY		
SLUCM NO.	LAND USE NAME	LUPZ CDNL or CNEL 57-62	Noise Zone II CDNL or CNEL 62-70	Noise Zone III CDNL or CNEL 70+
40	Transportation, communication and utilities			
41	Railroad, rapid rail transit, and street railway transportation	Y	Y	Y
42	Motor vehicle transportation	Y	Y	Y
43	Aircraft transportation	Y	Y	Y
44	Marine craft transportation	Y	Y	Y
45	Highway and street right-of-way	Y	Y	Y
46	Automobile parking	Y	Y	Y
47	Communication	Y	N	N
48	Utilities	Y	Y	Y
49	Other transportation, communication and utilities	Y	Y	N
50	Trade			
51	Wholesale trade	Y	Y	N
52	Retail trade – building materials, hardware and farm equipment	Y	Y	N
53	Retail trade – including shopping centers, discount clubs, home improvement stores, electronics superstores, etc.	Y	Y	N
54	Retail trade – food	Y	Y	N
55	Retail trade – automotive, marine craft, aircraft and accessories	Y	Y	N
56	Retail trade – apparel and accessories	Y	Y	N
57	Retail trade – furniture, home, furnishings and equipment	Y	Y	N
58	Retail trade – eating and drinking establishments	Y	Y	N
59	Other retail trade	Y	Y	N
60	Services			
61	Finance, insurance and real estate services	Y	Y	N
62	Personal services	Y	Y	N
62.4	Cemeteries	Y	Y	Y
63	Business services	Y	Y	N
63.7	Warehousing and storage	Y	Y <sup>4</sup>	Y <sup>4</sup>
64	Repair services	Y	Y	N
65	Professional services	Y	Y	N
65.1	Hospitals, other medical facilities	Y <sup>1</sup>	N	N
65.16	Nursing homes	Y <sup>1</sup>	N	N
66	Contract construction services	Y	Y	N
67	Government services	Y	Y	N
68	Educational services	Y <sup>1</sup>	N	N
68.1	Child care services, child development centers, and nurseries	Y <sup>1</sup>	N	N

TABLE B-3. LAND USE COMPATIBILITY: DEMOLITION AND LARGE ARMS NOISE, cont'd

LAND USE		SUGGESTED LAND USE COMPATIBILITY		
SLUCM NO.	LAND USE NAME	LUPZ CDNL or CNEL 57-62	Noise Zone II CDNL or CNEL 62-70	Noise Zone III CDNL or CNEL 70+
69	Miscellaneous			
69.1	Religious activities	Y <sup>1</sup>	N	N
70	Cultural, entertainment and recreational			
71	Cultural activities (& churches)	Y <sup>1</sup>	N	N
71.2	Nature exhibits	Y <sup>1</sup>	N	N
72	Public assembly	Y <sup>1</sup>	N	N
72.1	Auditoriums, concert halls	Y <sup>1</sup>	N	N
72.11	Outdoor music shells, amphitheaters	Y <sup>1</sup>	N	N
72.2	Outdoor sports arenas, spectator sports	Y	N	N
73	Amusements	Y	Y	N
74	Recreational activities (including golf courses, riding stables, water recreation)	Y	N	N
75	Resorts and group camps	Y	N	N
76	Parks	Y	N	N
79	Other cultural, entertainment and recreation	Y	N	N
80	Resource production and extraction			
81	Agriculture (except live- stock)	Y	Y	Y
81.5	Livestock farming	Y	N	N
81.7	Animal breeding	Y	N	N
82	Agriculture related activities	Y	Y	Y
83	Forestry activities	Y	Y	Y
84	Fishing activities	Y	Y	Y
85	Mining activities	Y	Y	Y
89	Other resource production or extraction	Y	Y	Y

Note 1: LUPZ- Land Use Planning Zone is a subdivision of Land Use Zone I and functions as a buffer for Noise Zone II. Communities and individuals often have different views regarding acceptable or desirable levels of noise. To address this, some local governments have implemented land use planning measures beyond Noise Zone II limits. In addition to mitigating current noise impacts, implementing such controls within the LUPZ can create a buffer to prevent the possibility of future noise conflicts.

Note 2: Although local requirements for on- or off-base housing may require noise-sensitive land uses within Noise Zone II, such land use is generally not compatible within Noise Zone II. Measures to achieve overall noise level reduction inside structures do not solve noise difficulties outside the structure. Barriers are not effective reducing the noise from artillery and armor, the detonation of either large caliber military munitions or a large quantity of explosives. Additionally, noise level reduction inside structures does not mitigate the vibration generated by the low-frequency energy of large caliber weapons firing and detonations.

Note 3: Within Zones, existing “noise sensitive land uses are considered as pre-existing incompatible land uses. In most cases these uses are not a risk to either mission sustainment or a community’s quality of life. Most long-term members near Army installations or activities acknowledge hearing military operations and activities but they are usually not alarmed or bothered by the noise.

Note 4: Although noise levels may be compatible, caution should be exercised in siting any activity which may be sensitive to vibration.

## C DATA USED TO GENERATE NOISE ZONES

### C.1 SMALL ARMS RANGE NOISE ZONES

Source: Small arms range utilization extracted from training ammunition utilization reports from FY2016-FY2017. Ammunition reports provided by FTIG Range Operations.

TABLE C-1. FTIG SMALL ARMS AMMUNITION UTILIZATION MATRIX

Facility/Airspace Subdivision	Pistol, 9 mm Live	Pistol, 9 mm Paint	AT-4 Simulator (9 MM)	Pistol, 38 Caliber Live	Pistol, 40 Caliber Live	Pistol, 45 Caliber Live	Rifle, 5.56 mm Live	Rifle, 5.56 mm Blank	Rifle, 5.56 mm Paint	Rifle, .22 Caliber Live	Rifle, 300 Winchester Magnum Live	Rifle, 7.62 mm Live	Machine Gun, SAW 5.56 mm Live	Machine Gun, SAW 5.56 mm Blank	Machine Gun, SAW 5.56 mm Paint	Machine Gun, 7.62 mm Live	Machine Gun, 7.62 mm Blank	Machine Gun, 50 Caliber Live	Machine Gun, 50 Caliber Blank	Shotgun, 12 Gauge Live	Shotgun, 12 Gauge Blank
RG 03	x						x		x	x			x			x				x	
RG 05							x						x								
RG 06							x					x				x					
RG 06 DEF																	x				
RG 07_AUTOPISTOL	x				x																
RG 08 QUAL							x														
RG 08 ZERO							x														
RG 08A_KD							x			x		x									x
RG 09 QUAL							x														
RG 09 ZERO							x														
RG 11 QUAL							x														
RG 12A							x					x									
RG 13	x				x		x	x					x								
RG 13A	x						x						x								
RG 14	x				x		x	x					x								
RG 14A	x						x														
RG 15	x						x						x			x					
RG 16	x						x	x					x								
RG 17 MPQC	x																				x
RG 20_UAC							x														
RG 23C																					
RG 30_CACTF		x												x			x				



TABLE C-2. FTIG SMALL ARMS AMMUNITION UTILIZATION MATRIX

Facility/Airspace Subdivision	Pistol, 9 mm Live	Pistol, 9 mm Paint	AT-4 Simulator (9 MM)	Pistol, 38 Caliber Live	Pistol, 40 Caliber Live	Pistol, 45 Caliber Live	Rifle, 5.56 mm Live	Rifle, 5.56 mm Blank	Rifle, 5.56 mm Paint	Rifle, .22 Caliber Live	Rifle, 300 Winchester Magnum Live	Rifle, 7.62 mm Live	Machine Gun, SAW 5.56 mm Live	Machine Gun, SAW 5.56 mm Blank	Machine Gun, SAW 5.56 mm Paint	Machine Gun, 7.62 mm Live	Machine Gun, 7.62 mm Blank	Machine Gun, 50 Caliber Live	Machine Gun, 50 Caliber Blank	Shotgun, 12 Gauge Live	Shotgun, 12 Gauge Blank	
RG 31_UAC									x													
RG 32 SHOOT HSE	x				x		x		x													
RG 33 BRCH FAC																					x	x
RG 34_ISBC							x	x					x	x								
RG 35_MPMG							x						x	x		x		x				
RG 36_MK19												x	x			x		x				
RG 37_SNIPER							x				x	x				x						
RG 38											x		x			x		x				
RG 39_IED								x														
RG 39-B SIMMUNITION VILLAGE		x																				
TA A-16A								x														
TA A-17								x														
TA B-09A								x						x				x				
TA B-09B								x	x					x				x				
TA B-09B SIMMUNITION VILLAGE		x						x	x					x	x			x				
TA B-09C								x						x				x				
TA B-09C SIMMUNITION VILLAGE		x						x						x				x				
TA B-10A								x						x				x				
TA B-11A								x						x				x				
TA B-11B								x						x				x				
TA B-12A								x						x				x				
TA B-12B								x						x				x				
TA C-01								x						x				x				
TA D-03A								x						x				x				

**C.2 LARGE CALIBER AND DEMOLITION NOISE ZONES (CDNL)**

Source: Large caliber training ammunition utilization reports for FTIG from FY2016-FY2017 were used for contour production. Ammunition reports provided by FTIG Range Operations.

TABLE C-3. FTIG LARGE CALIBER/DEMOLITION AMMUNITION EXPENDITURE

Facility/Airspace Subdivision	Nomenclature	2 Year Average (FY16 & FY17)	Daytime (0700-2200)	Nighttime (2200-0700)
BOMB RG	2.75" Rocket, Inert	21	18	3
	30mm Gun, Inert	15480	13158	2322
DEMO B	Demolition, Banaglore, M1A2	1441	1441	0
	Demolition, C-4, 1.25 lb	781	781	0
	Demolition, Cratering, 40 lb	14	14	0
	Demolition, Shaped, 40 lb	8	8	0
DEMO D	CHG, Demo Roll M186 (RQMT in Feet)	100	100	0
	Demolition, Banaglore, M1A2	55	55	0
	Demolition, C-4, 1.25 lb	3144	3144	0
	Demolition, Cratering, 40 lb	53	53	0
	Demolition, Shaped, 40 lb	22	22	0
	Demolition, TNT, 0.25 lb	40	40	0
	Demolition, TNT, 1 lb	400	400	0
FP B-10-02	155mm Howitzer, High Explosive	36	31	5
FP B-11-04	105mm Howitzer, High Explosive	38	32	6
FP B-12-03	105mm Howitzer, High Explosive	102	87	15
	155mm Howitzer, High Explosive	36	31	5
FP C-04-07	155mm Howitzer, Inert	10	9	2
FP C-05-03	120mm Mortar, High Explosive	70	60	11
	120mm Mortar, Inert	222	189	33
	81mm Mortar, High Explosive	42	36	6
	81mm Mortar, Inert	71	60	11
FP D-03-02	81mm Mortar, High Explosive	4	3	1
	81mm Mortar, Inert	40	34	6
FP D-03-08	105mm Howitzer, High Explosive	37	31	6
	155mm Howitzer, High Explosive	150	128	23
FP D-03-10	105mm Howitzer, High Explosive	71	60	11
	120mm Mortar, High Explosive	6	5	1
	120mm Mortar, Inert	51	43	8
	155mm Howitzer, High Explosive	134	114	20
	155mm Howitzer, Inert	18.5	16	3
FP F-01-01	60mm Mortar, Inert	80	68	12
FP F-01-08	60mm Mortar, Inert	162	138	24
	81mm Mortar, Inert	114	97	17
FP F-01-10	120mm Mortar, High Explosive	116	98	18
	120mm Mortar, Inert	198	168	30
	81mm Mortar, High Explosive	36	31	5
	81mm Mortar, Inert	167	142	25

TABLE C-4. FTIG LARGE CALIBER/DEMOLITION AMMUNITION EXPENDITURE

Facility/Airspace Subdivision	Nomenclature	2 Year Average (FY16 & FY17)	Daytime (0700-2200)	Nighttime (2200-0700)
MEDINA RDG	105mm Howitzer, High Explosive	1025	871	154
	105mm Howitzer, Inert	78	66	12
	155mm Howitzer, High Explosive	925	786	139
	155mm Howitzer, Inert	18	15	3
OP 13	60mm Mortar, High Explosive	18	15	3
	60mm Mortar, Inert	86	73	13
	81mm Mortar, High Explosive	120	102	18
	81mm Mortar, Inert	14	12	2
R 5802B	2.75" Rocket, Inert	12	10	2
	30mm Gun, Inert	4757	4043	713
RG 19	Demolition, C-4, 1.25 lb	1	1	0
	Hand Grenade, M67	427	427	0
	Mine, Claymore, M18A1	24	24	0
RG 23 DOOR	2.75" Rocket, Inert	178	151	27
	30mm Gun, Inert	1430	1216	215
RG 23A	Hand Grenade, M26	200	200	0
	Hand Grenade, M67	255	255	0
RG 23C	AT-4 Rocket, High Explosive	43	43	0
RG 23D	40mm Grenade, High Explosive	267	267	0
RG 33 BRCH FAC	Demolition, C-4, 1.25 lb	16	16	0
	Demolition, TNT, 0.25 lb	5	5	0
RG 35_MPMG	60mm Mortar, High Explosive	15	13	2
	60mm Mortar, Inert	126	107	19
	81mm Mortar, High Explosive	11	9	2
	81mm Mortar, Inert	15	13	2
RG 36_MK19	40mm Grenade, High Explosive	944	944	0
	Demolition, C-4, 1.25 lb	3	3	0
RG 37_SNIPER	25mm Gun, Inert	2774	2358	416
RG 38	120mm Tank, Inert	9	8	1
	Javelin, High Explosive	9	9	0
	Mine, Claymore, M18A1	5	5	0
RG 39_IED	Demolition, C-4, 1.25 lb	4	4	0
TA D-02	Demolition, C-4, 1.25 lb	1	1	0
TA D-07B	Demolition, C-4, 1.25 lb	2	2	0
TRAIL 4	Demolition, C-4, 1.25 lb	15	15	0

**C.4 AIRCRAFT NOISE ZONES**

Source: Airfield traffic counts from 2017. Airfield operations data provided by FTIG Air Traffic and Airspace Officer. Percentage of day vs. night flight was estimated by Airspace Officer.

TABLE C-5. MUIR AAF ANNUAL AIRCRAFT OPERATIONS

<b>Aircraft Type</b>	<b>Annual Average</b>	<b>Day (0700-2200)</b>	<b>Night (200-0700)</b>
AH-64	28,116	16,870	11,246
OH-58	11,715	7,029	4,686
CH-47	7,029	4,217	2,812
<b>Total</b>	<b>46,860</b>	<b>28,116</b>	<b>18,744</b>

## D REFERENCES

DOD, 2015, Department of Defense Instruction 4165.57, Air Installations Compatible Use Zones (AICUZ), May 2011, as amended March 2015.

DODI, 2004, Department of Defense Instruction 3030.3, Joint Land Use Study (JLUS) Program.

DMVA, 2016, Pennsylvania Department of Military and Veterans Affairs, Economic Impact Report, Economic Impact in Communities for Fiscal Year 2016, Pennsylvania Army and Air National Guard.

FICUN, 1980, Guidelines for Considering Noise in Land Use Planning and Control.

FTIG, 2017a, Headquarters Garrison Command, Fort Indiantown Gap Aviation Procedures Guide, January 2017.

FTIG, 2017b, Pennsylvania National Guard, Fort Indiantown Gap Factsheet, November 2017.

FTIG, 2018a, Headquarters Garrison Command, Fort Indiantown Gap Regulation 350-2, Range Operations, Directorate of Plans, Operations, Training and Security, May 2018.

FTIG, 2018b, Army Compatible Use Buffer (ACUB) Program, Fort Indiantown Gap National Guard Training Center, Short Brief, May 2018.

JLUS, 2015, Fort Indiantown Gap Joint Land Use Study, Lebanon County Planning Department and Matrix Design Group, January 2015.

Pater, 1976, "Noise Abatement Program for Explosive Operations at NSWC/DL," Presented at the 17<sup>th</sup> Explosives Safety Seminar of the DOD Explosives Safety Board.

Pennsylvania National Guard, 2018, Homepage, URL: <http://png.pa.gov>

Public Law 92-574, 1972, 92<sup>nd</sup> U.S. Congress, Noise Control Act of 1972.

Public Law 95-609, 1978, 95<sup>th</sup> U.S. Congress, Quiet Communities Act of 1978.

REPI, 2017, Department of Defense, Readiness and Environmental Protection Integration (REPI) Program, Project Profile, U.S. Army Fort Indiantown Gap, Pennsylvania.

Rylander, *et al.*, 1974, "Re-Analysis of Aircraft Noise Annoyance Data against the dBA Peak Concept," *Journal of Sound and Vibration*, Volume 36, pages 399-406.

Siskind, 1989, "Vibrations and Airblast Impacts on Structures from Munitions Disposal Blasts," *Proceedings, Inter-Noise 89*, G. C. Maling, JR., editor, pages 573-576.

University of Utah, 1958, Explosives Research Group Report No. 12, Measurement of Air and Ground Shock Disturbances Arising from Demolition Activities at Letterkenny Ordnance Depot.

U.S. Air Force, 2005, SELcalc2 Noise Model, Wright-Patterson Air Force Base, OH.

U.S. Air Force, 2013, Noisemap – BaseOps 7.357 - AAM, Wright-Patterson Air Force Base, OH.

U.S. Air Force, 2018, Bollen Air-to-Ground Weapons Range Complex, Fort Indiantown Gap, Bollen Range Brochure, U.S. Air Force 193<sup>rd</sup> Special Operations Wing.

U.S. Army 1983, USAEHA Environmental Noise Assessment No. 52-34-0415-83, Noise Levels from Machine Guns, Grenade and Artillery simulators from Training at Sudbury Annex, Fort Devens, MA, 23-24 March 1983.

U.S. Army, 1984, Army Environmental Hygiene Agency, Environmental Noise Assessment No. 52-34-0442-84, Noise Measurement Study, Camp Bullis, Texas, 27 February – 2 March 1984.

U.S. Army 1989, USAEHA Environmental Noise Assessment No. 52-34-0447-89, Results of Monitoring Edgewood Area Field Training Exercise Site, Aberdeen Proving Ground, MD, June 1989.

U.S. Army, 1999, Center for Health Promotion and Preventive Medicine, Health Hazard Assessment Report on the 40mm XM1001 Canister Cartridge for the MK-19 Mod 3 Grenade Machine Gun, No. 69-37-2735-00, November 1999.

U.S. Army, 2007, Army Regulation 200-1, Environmental Protection and Enhancement, Chapter 14 Operational Noise.

U.S. Army, 2009, U.S. Army Construction Engineering Research Laboratories, BNOISE2 Computer Model, Version 1.3 2009-11. 30.

U.S. Army, 2012, U.S. Army Public Health Command, Pennsylvania Army National Guard Statewide Operational Noise Management Plan, Operational Noise Program, June 2012.

U.S. Army, 2015, U.S. Army Engineer Research and Development Center (ERDC), SARNAM Computer Model, Version 2015-07-27

U.S. Census Bureau, 2018. Homepage, URL: <http://www.census.gov>