Appendix F

Noise Analysis

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Blue Ridge Research and Consulting, LLC

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Noise Analysis in Support of the Environmental Impact Statement for the Proposed Modernization and Expansion of Townsend Bombing Range, Georgia

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1 Overview

This noise analysis report supports the US Marine Corps (USMC) preparation of an Environmental Impact Statement (EIS) on the Proposed Modernization and Expansion of Townsend Bombing Range (TBR), Georgia. This report is divided into sections that provide an overview of the study's objective and goals. Section 1.1 outlines the purpose of the study; Section 1.2 summarizes the noise metrics used to describe and quantify the noise environments for the Proposed Action at TBR; and Section 1.4 briefly describes the computer noise analysis models used to calculate the noise exposure. Section 2 provides a description of TBR in its current and proposed configurations. Section 3 describes the aircraft operations at TBR, and Section 4 provides the resulting noise contours for current and proposed alternatives.

1.1 Purpose

The USMC proposes to modernize and expand TBR, Georgia, to accommodate the use of inert (with spotting charges) precision-guided munitions (PGMs) with their associated larger land requirements in order to provide a modern realistic training environment on the US East Coast. To accomplish this, the USMC proposes to acquire lands in the vicinity of TBR to create new target areas to allow for a greater variety of training activities. Currently, Marine Aircraft Group (MAG) 31 does not have a range within the local flying area capable of supporting the required level of PGM training. The goal for the proposed modernization and expansion of TBR is to meet the aviation training requirements and achieve readiness proficiency for air-to-ground operations for USMC East Coast F/A-18 pilots. Through modernization and expansion, TBR would also maintain pace with the evolving training requirements of the USMC and the other U.S. military services by planning for and managing range modernization in accordance with the *Air National Guard (ANG) Range Master Plan* (ANG 2005) for TBR and the *Townsend Bombing and Gunnery Range 2005 Comprehensive Range Plan and Business Strategy* (Georgia Air National Guard [GA ANG] 2005).

1.2 Introduction

This noise study models operations of the F/A-18 flight training activities conducted throughout a normal year at TBR, based on the current training readiness requirements used by the USMC (Wilson, 2011). These operations include the following general training events: Close Air Support (CAS), Aerial Reconnaissance (AR), Air Interdiction (AI), Large Force Exercise (LFE), and Low Altitude Training (LAT). These events involve flights with no ordnance, general purpose bombs, laser guided training rounds (LGTR), precision-guided munitions, and/or strafing. CAS involves aircraft engaging hostile targets that are close to friendly ground forces. The close proximity of friendly and hostile forces requires precision and coordination with the friendly ground forces. AR involves the use of on-board sensors to collect intelligence around an area of concern. AI involves the striking of enemy ground targets away from ground personnel. LFE involves the coordination of efforts and movements for many aircraft along with diverse ground forces. LAT involves basic flight training operations at low to very low altitudes.

1.3 Noise Metrics

An assessment of aircraft noise requires a general understanding of how sound affects people and the natural environment, as well as how sound is measured. Around and underneath military training special use airspace (SUA) units, the noise environment is normally described in terms of the time-average sound level generated by aircraft operating in that airspace. The federal noise measure used for assessing long-term aircraft noise exposures in communities in the vicinity of airfields is the DNL (which is sometimes denoted by L_{dn}), expressed as decibels (dB). DNL is an average sound level generated by all aviation-related operations during an average 24-hour period with sound levels of nighttime noise events adjusted by adding a 10 dB penalty. Daytime is defined as the period from 0700 to 2200 hours, and nighttime is the period from 2200 to 0700 hours the following morning. The 10 dB penalty accounts for the generally lower background sound levels and greater community sensitivity to noise during nighttime hours. DNL has been found to provide the best measure of long-term community reaction to transportation noises, especially aircraft noise.

Aircraft noise generated in SUA is somewhat different from that associated with airfield operations. As opposed to patterned or continuous noise environments associated with airfields, overflights within SUA can be highly variable in occurrence and location. Individual military overflight events also differ from typical community noise events in that noise from a low-altitude, high-airspeed flyover can have a sudden onset (i.e. exhibiting a rate of increase in sound level – onset rate – of up to 30 to 150 dB per second.)

To represent these differences, the conventional DNL metric is adjusted to account for the “surprise” effect of the sudden onset of aircraft noise events on humans with an adjustment up to 11 dB above the normal Sound Exposure Level (Stusnick, et al., 1992; Stusnick, et al., 1993). Onset rates between 15 to 150 dB per second require an adjustment of 0 to 11 dB, while onset rates below 15 dB per second require no adjustment. The adjusted DNL is designated as the onset-rate adjusted day-night average sound level (L_{dnr}). L_{dnr} employs A-weighted sound levels. “A-weighted” denotes the adjustment of the frequency content of a noise event to represent the way in which a human with average hearing senses moderate levels of noise.

Another noise generated on TBR is from aerial strafing. This noise is impulsive in nature with sudden bursts of noise from the firing of the F/A-18C/D’s M61A2 20mm gun. For impulsive noise, C-weighted sound levels are used. “C-weighted” denotes an adjustment to the frequency content of a noise event to represent human response to louder noise levels. Compared to A-weighting, C-weighting enhances the lower frequency content. Strafing noise has two components: ballistic waves (sonic booms) from the bullets, and muzzle blast from the gun firing. The ballistic waves from the bullets only occur forward of the firing point, whereas muzzle blast can be heard in all directions. The DNL metric is still utilized to characterize strafing noise, but C-weighted sound levels are utilized to account for the lower frequency content and higher levels of strafing. For strafing, the DNL is denoted as CDNL (or L_{Cdn}). In addition to CDNL, Peak levels (dB_{Pk}) are used to describe the strafing noise to assess the potential for complaints. The US Army has established Peak levels of 115 dB_{Pk} and 130 dB_{Pk} that correspond to the likelihood of complaints from the nearby population. For levels between 115 and 130 dB_{Pk} some complaints may occur, whereas if the peak levels are above 130 dB_{Pk}, complaints are expected (US Army, 2007).

1.4 Computerized Noise Exposure Models

1.4.1 MOA Range NoiseMap (MR_NMAP)

Analyses of aircraft noise exposures and compatible land uses around and underneath SUAs are normally accomplished using MR_NMAP (Lucas, 1995). The US Air Force developed this general-purpose computer model for calculating noise exposures occurring away from airbases, since aircraft noise is also an issue within Military Operations Areas (MOAs) and ranges, as well as along Military Training Routes (MTRs). This model expands the calculation of noise exposures away from airbases by using algorithms from both NOISEMAP (Moulton, 1992; Czech and Plotkin, 1998) and ROUTEMAP (Bradley, 1996). MR_NMAP uses two primary noise models to calculate the noise exposure: track and area operations. Track operations are for operations that have a well-defined flight track, such as MTRs, aerial refueling, and strafing tracks. Area operations are for operations that do not have well defined tracks, but occur within a defined area, such as air-to-air combat within a MOA.

The program has a user interface, MR_OPS, for the development of the input data. For track operations, input requirements are the same as for ROUTEMAP, but more than just MTRs can be modeled. For area operations, the model allows flexibility. If little is known about the airspace utilization within a MOA, then the MOA boundaries can simply be used, and the operations are uniformly distributed within the defined area. However, if more is known about how and where the aircraft fly within the MOA, subareas can be defined within the MOA to more accurately model the noise exposure.

Once the airspace is defined, the user must describe the different types of missions occurring within each airspace segment. Individual aircraft missions include the altitude distribution, airspeed, and engine power settings. These individual profiles are coupled with airspace components and annual operational rates.

Once the airspace and operational parameters are defined, MR_NMAP calculates the resulting L_{dn} or L_{dnr}. The model calculates these noise metrics either for a user-defined grid or at user-defined specific points. The grid calculation can be passed to NMPLOT to plot the noise contours as is provided in this analysis. The specific point calculation generates a table that provides the noise exposure, as well as the top contributors to the noise exposure.

1.4.2 Air Gunnery Noise Model

A number of aircraft and ground-based weapon system noise models have been developed over the past 30 years to estimate noise levels from military operations. The results from these models are used to assess the potential for community and environmental impacts from existing and proposed operations. Current Department of Defense (DoD) noise models use common aircraft and weapon system source noise databases maintained by the Air Force Research Laboratory, U.S. Army Construction Engineering Research Laboratory, and Naval Facilities Engineering Command. However, these models and the source noise databases do not provide the capability to assess noise impacts due to airborne weapon operations. Thus, a new computer model has been developed to address the generation and propagation of noise from air-weaponry operations (Ikelheimer et al, 2007; Downing et al, 2007, Hobbs et al, 2008). The model handles the complexity of the distributed noise events while maintaining accurate acoustical modeling that is required for environmental noise analysis.

One of the complexities in this type of model is that aircraft rarely fly the exact attack run profile prescribed, and in some cases, the attack run is simply a generalized fan where the pilot can approach the target from a range of headings. To solve this problem of an unknown source location, a generalized statistical firing space is used. This space is defined by the parameters of the attack run with a three dimensional Gaussian distribution of firing points. The noise footprint from this space is then calculated to represent the noise from a single bullet fired from within the space. This statistical method is not representative of a single bullet fired, but is rather the average noise expected once a statistically large number of bullets have been fired. The noise footprint can then be included in a larger environmental noise model that determines the noise contour from a whole range of operations.

The model consists of several different programs designed to operate together. The following is a complete list of the programs provided in the initial release:

AG_BoomModel.exe,
AG_DefineRun.exe,

AG_FrontEnd.exe,
Air_Gunnery_Model.exe,
LayerBuilder.exe, and
TargetBuilder.exe.

The AG_BoomModel program is designed to calculate the noise from the sonic boom from the projectiles. The noise algorithm itself is based on Carlson's simplified sonic boom theory (1978). It uses the projectile shape factor, length, and speed profile to calculate the footprint of the sonic boom.

The AG_DefineRun program provides a graphical user interface to help the user define a statistical volume for a firing profile. This module provides the user a way to see the firing line, target, and statistical volume graphically. The program takes that information and generates a statistical volume. This volume is then separated into individual firing points within the volume. Each point is provided a statistical likelihood that a bullet was fired at that location. The total probability of the entire volume is defined as 1.00, making the likelihood that a bullet was fired somewhere within the volume 100%. The likelihood that a single bullet was fired at any one spatial location within the volume is less than 1.00, and is a function of where in the volume it is, and the definition of the distribution.

AG_FrontEnd is the initial user interface for the Air Gunnery Model. It is the starting point for creating new cases or importing cases from other sources. When the program is initially launched, it shows an empty grid similar to a spreadsheet. This is the main screen for viewing operational data, with the column headings providing details about individual operations.

The Air_Gunnery_Model is the core calculation engine for determining the muzzle blast and propulsion noise. The primary noise metric is the C-weighted SEL along with correlations to peak levels, A-weighted SELs, and unweighted SELs. With the CSEL, the corresponding L_{Cdn} can be calculated given the number of munitions fired. This program operates entirely from a command line. The command line argument is a control file that contains all of the information necessary to compute the noise from a single statistical volume.

The input file is relatively simple and is used for the muzzle blast calculation as well as for the sonic boom calculations. The output is a NMPlot grid file that contains all of the cases information. It lists each of the modeled firing points together with their probabilities.

2 Description of Current and Proposed Range

2.1 Townsend Bombing Range

TBR is located in McIntosh County in Southeast Georgia. Figure 2-1 provides an overview of the range location in relation to the nearby communities. The range is approximately 21 miles south of Fort Stewart, and it is 20 miles inland to the Atlantic Ocean. TBR is owned by Marine Corps Air Station (MCAS) Beaufort and operated by the GA ANG under a host-tenant real estate agreement with MCAS Beaufort. The GA ANG provides daily operational control and range maintenance.

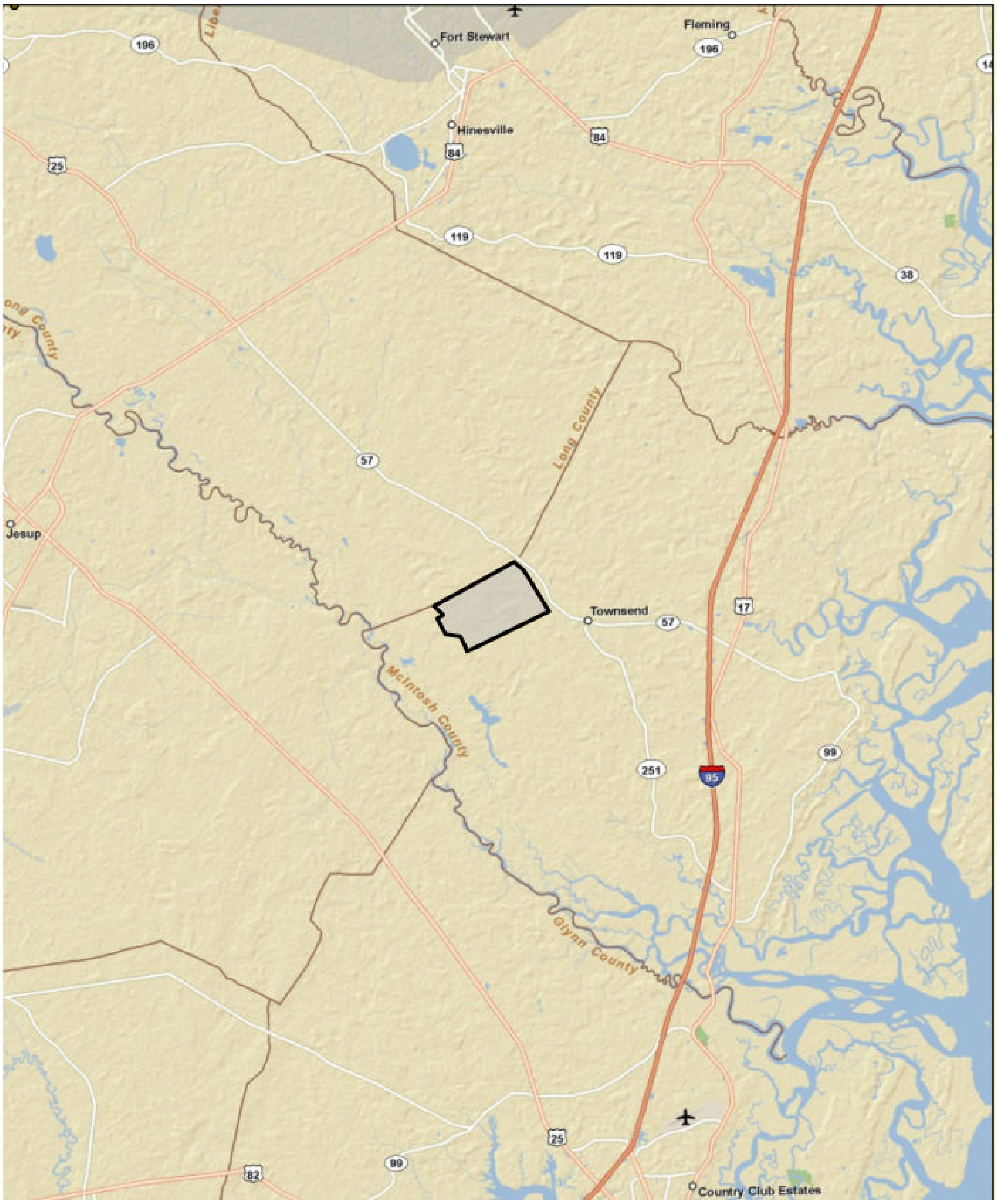

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Figure 2-1. Existing Townsend Bombing Range Location (range outlined in black and gray-shaded)

TBR is one of four air-to-ground ranges within the USMC's inventory on the East Coast and one of seven in the United States that supports air combat/air-to-ground operations. MAG 31, based at MCAS Beaufort, South Carolina, is the primary user of TBR; however, fixed-wing and rotary-wing pilots from multiple service branches, originating from numerous air installations on the East Coast and from Carrier Battle Groups in the Atlantic Ocean, also train at TBR. TBR is used by all services to practice air-to-ground ordnance delivery, gunnery, electronic warfare, tactical air control of ground attack aircraft, and other combat skills. All current TBR training involves the use of only inert munitions, which contain no explosives, but may contain a small smoke charge (spotting charge) to assist in scoring the event and providing feedback to the pilot.

2.2 Surrounding Airspace Units

TBR is unique among East Coast air-to-ground training ranges due to the large amount of SUA associated with the Range and its proximity to offshore training areas. The volume of airspace makes TBR an ideal facility for realistic combat training. SUA is airspace designated by the Federal Aviation Administration (FAA) that has a defined vertical and lateral limit where military activity or unusual flight conditions may occur. Its designation serves to alert any non-participating aircraft that military activity is taking place in the area. Airspace associated with TBR includes Restricted Area R3007, Coastal MOAs, offshore Warning Areas (W-157A) and the associated MTRs (VR 45/25, VR 1003, VR 1066, and VR 1004/1041), which serve as airspace corridors for navigation between SUA units and for low-level flight and tactical training.

2.3 Proposed Range Expansion

The USMC proposes to modernize and expand TBR to accommodate the use of inert (with spotting charges) PGMs with their associated larger land requirements. To accomplish this, the USMC proposes to acquire lands in the vicinity of TBR to create new target areas to allow for a greater variety of training activities as highlighted in Figure 2-2. Currently, no range within MCAS Beaufort local flying area is capable of supporting the MAG 31's required level of PGM training. In terms of noise generation, the Proposed Action will involve the following changes:

- Increase the number of high and medium altitude training events,
- Potentially increase the number of F/A-18 sorties, and
- Expand the area of training events.

Part of the Proposed Action includes a modification of the airspace within R3007. This modification involves lowering the floor of the restricted airspace from 100 ft above ground level (AGL) to the ground in the expanded portion of the range. The Proposed Action does not involve any other change in the surrounding SUA units. Thus, this modification is not as significant as the three items listed above in terms of projected noise, since F/A-18s operate above 100 ft AGL while training at the range.

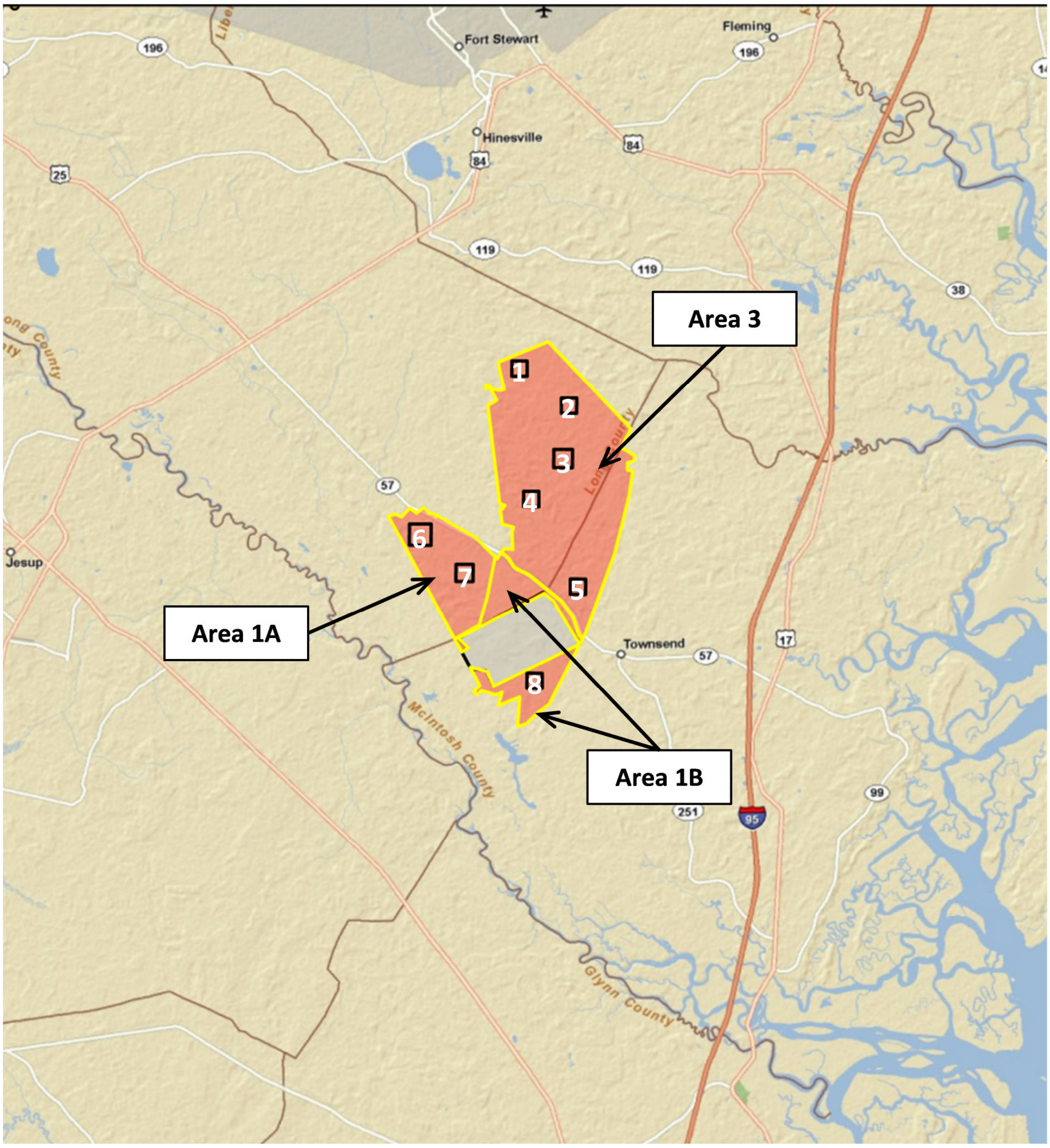

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Figure 2-2. Proposed Townsend Bombing Range Acquisition Areas along with Proposed Target Areas

The Proposed Action involves four alternatives that involve portions of, or all of, the proposed acquisition areas highlighted in Figure 2-2. Alternative 1 includes an expansion of the range for all of the highlighted areas west of Highway 57, which is referred to as Areas 1A and 1B. Areas 1A and 1B would include three additional Target Areas, which are numbered 6, 7, and 8 from north to south. Alternative 2 involves a range expansion in the area highlighted east of Highway 57 and is referred to as Area 3. Area 3 would include five additional Target Areas, which are numbered 1 through 5 from north to south. Alternative 3 involves all of the Areas 1A, 1B, and 3, as well as the associated eight new Target Areas. Alternative 4 includes Areas 1B and 3. This alternative includes Target Areas 1 through 5 and Target Area 8 that is directly south of the current range area.

3 Airspace Training Operations at Townsend Bombing Range

Assessment of aircraft noise within SUA requires a range of data to describe the types, frequency, and location of noise generating operations occurring within the SUA. The primary source of data is the training and readiness manual, NAVMC 3500.50A. MAG 31 is comprised of seven F/A-18 Hornet squadrons, also known as “gun squadrons”. The primary missions that MAG 31 execute at TBR include CAS, air interdiction, airborne reconnaissance, forward air control (airborne), and tactical air control (airborne). Currently, only 47% of the F/A-18’s air-to-ground training syllabus requirements can be fully accomplished at TBR with its current size and configuration. With the expansion, 72% to 85% of the training syllabus could be accomplished at the range (Wilson, 2011).

For this noise analysis, only changes in MAG 31 F/A-18 operations are analyzed. This limitation will not restrict the comparison between current and projected scenarios since the MAG 31 F/A-18s are the primary user of the range as well as one of the loudest aircraft types operating at the range.

3.1 Annual Flight Operations

Table 3-1 provides the annual F/A-18 sorties conducted at TBR for current and proposed alternatives. It should be noted that a sortie for this analysis is defined as one aircraft flying from home base to TBR, conducting 30 minutes of training, and returning to home base.

Table 3-1. Annual MAG 31 F/A-18 Sorties at TBR for Current and Proposed Alternatives

Sortie Distribution	Current	Alternatives			
		1	2	3	4
Total Sorties	2,358	3,583	4,243	4,243	4,243
Precision Guided Muntions	-	1,226	1,509	1,509	1,509
General Purpose	1,332	1,131	1,226	1,226	1,226
Laser Guided Training Rounds	377	377	376	376	376
No Ordnance	272	472	754	754	754
Low Altitude Training	283	283	284	284	284
Scored Strafe	94	94	94	94	94

3.2 Area Operations

3.2.1 Mission Type Groups

The various training missions conducted at TBR are grouped into three general groups, which sort the missions by the amount of airspace required. These three groups are referred to as small, medium, and large. The small grouping is for missions that will remain within a 12 NM radius of the Target Areas but within the SUA limits. This group includes CAS and Forward Area Control (FAC) type missions. The medium grouping is for missions that will remain within a 20 NM radius of the Target Areas but within the SUA limits. This group includes Aerial

Reconnaissance, Tactical Air Control, and LGTR type missions. Further, the large grouping is for missions that will utilize the entire TBR/Coastal MOA complex airspace. This group includes air interdiction and large force exercises. The missions in these three groups will involve either no ordnance or a mix of general-purpose bombs and PGMs. For the noise analysis, the initial assumption for the proposed operations is that each Target Area will be equally utilized under the individual alternatives. This assumption provides for a uniform distribution of the operations within each defined area.

Another specific mission type is Low Altitude Training (LAT), which will remain within the R3007 boundaries. This mission type does not involve any munitions release.

3.2.2 Altitude Distributions for Area Operations

The different types of training missions involve a distribution of altitudes at which the aircraft operate. Table 3-2 provides the altitude distributions for the various mission types for the current operational conditions. For current conditions, no PGM missions are conducted so these missions are not modeled. Table 3-3 provides the expected altitude distributions for Alternative 1 proposed operations. Under this alternative, operations for general-purpose bombing and no ordnance missions are shifted lower. However, the addition of PGM missions moves more operations above 10,000 ft as demonstrated by the composite column, which is the distribution for all of the area operations. Table 3-4 provides the expected altitude distributions for Alternatives 2, 3, and 4 proposed operations. For these alternatives, the composite altitude distribution is shifted higher.

Table 3-2. Altitude Distributions for General Mission Types for Current Operations at Townsend Bombing Range

Altitude Bands	General Purpose & No Ordnance	Low Altitude Training	Precision Guided Munitions	Laser Guided Training Rounds	Composite
0 to 3,000 ft	11.9%	90%	NA	0%	19.7%
3,000 to 10,000 ft	50.4%	10%	NA	10%	38.6%
10,000+ ft	37.7%	0%	NA	90%	41.7%

Table 3-3. Altitude Distributions for General Mission Types for Alternative 1 Proposed Operations at Townsend Bombing Range

Altitude Bands	General Purpose & No Ordnance	Low Altitude Training	Precision Guided Munitions	Laser Guided Training Rounds	Composite
0 to 3,000 ft	19.5%	90%	0%	0%	16.3%
3,000 to 10,000 ft	46.6%	10%	10%	10%	26.8%
10,000+ ft	33.9%	0%	90%	90%	56.9%

Table 3-4. Altitude Distributions for General Mission Types for Alternatives 2, 3, and 4 Proposed Operations at Townsend Bombing Range

Altitude Bands	General Purpose & No Ordnance	Low Altitude Training	Precision Guided Munitions	Laser Guided Training Rounds	Composite
0 to 3,000 ft	20.0%	90%	0%	0%	15.7%
3,000 to 10,000 ft	46.5%	10%	10%	10%	27.4%
10,000+ ft	33.5%	0%	90%	90%	56.9%

3.3 Track Operations

Another mission conducted at TBR is a scored strafe. Currently, this mission is performed at the strafe pit located within the range. For Alternatives 2, 3, and 4, an additional scored strafing pit will be located in Target Area 5. Under these alternatives, the scored strafing missions will be equally distributed between the two strafing pits. Figure 3-1 provides a diagram of the scored strafing patterns. The major features of this left turn pattern include a straight run-in distance of 1.3 NM to the target with an abeam distance of 2 NM.

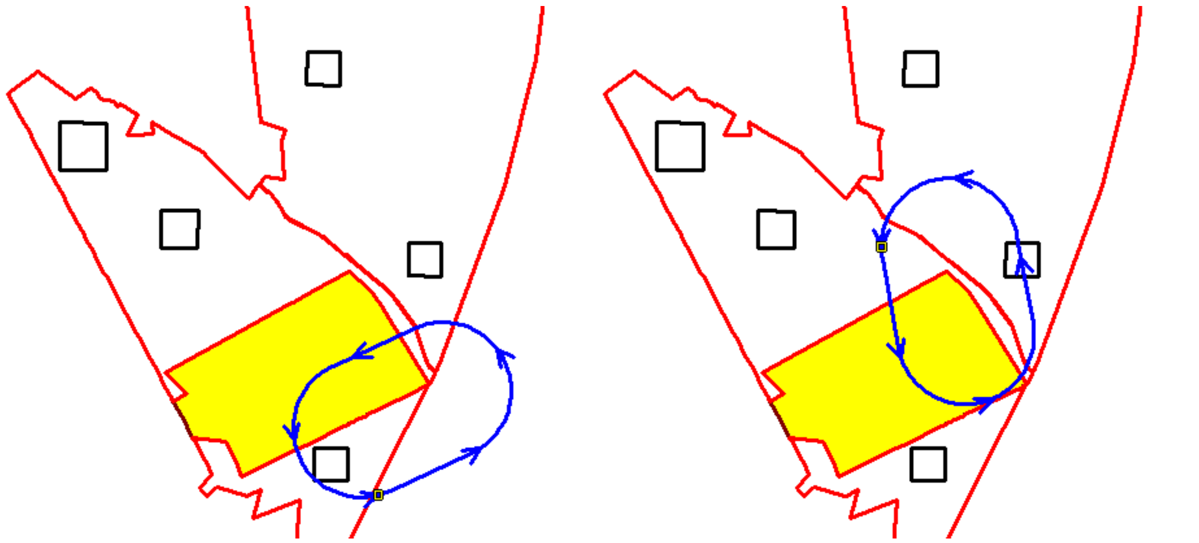

Figure 3-1. Scored Strafe Patterns (in blue) at TBR: current (left) and proposed additional pit at Target Area 5 (right)

4 Projected Aircraft Noise Exposure

The operational parameters described in Section 3 for the current and proposed operations are used to calculate the noise exposures at TBR. These noise calculations involve two different types of noise, aircraft noise and air gunnery noise.

4.1 Aircraft Noise

MR_NMAP was used to develop the noise levels for the aircraft operations. Table 4-1 provides the general noise levels for the different airspace units within TBR/Coastal MOA complex.

Table 4-1. L_{dnr} (dBA) values for Air Operations at Townsend Bombing Range for Baseline and Proposed Scenarios

Airspace Unit	Scenario				
	Current	Alternative 1	Alternative 2	Alternative 3	Alternative 4
R3007	48 to 55	50 to 55	50 to 55	50 to 55	50 to 55
Coastal MOA 1	38 to 49	38 to 47	39 to 45	39 to 44	39 to 44
Coastal MOA 2	47	44	45	44	44
Coastal MOA 4	36 to 47	36 to 44	37 to 45	37 to 44	37 to 44
Coastal MOA 5	36	36	37	37	37
Coastal MOA 8	36	36	37	37	37

Figure 4-1 to Figure 4-5 show the L_{dnr} 55 dBA contour for the current conditions and the proposed Alternatives 1 through 4, respectively. The 55 dBA L_{dnr} contours are generated by the scored strafe operations. From these figures and the values in Table 4-1, the expansion of the range will not increase the aircraft noise levels in TBR/Coastal MOA complex.

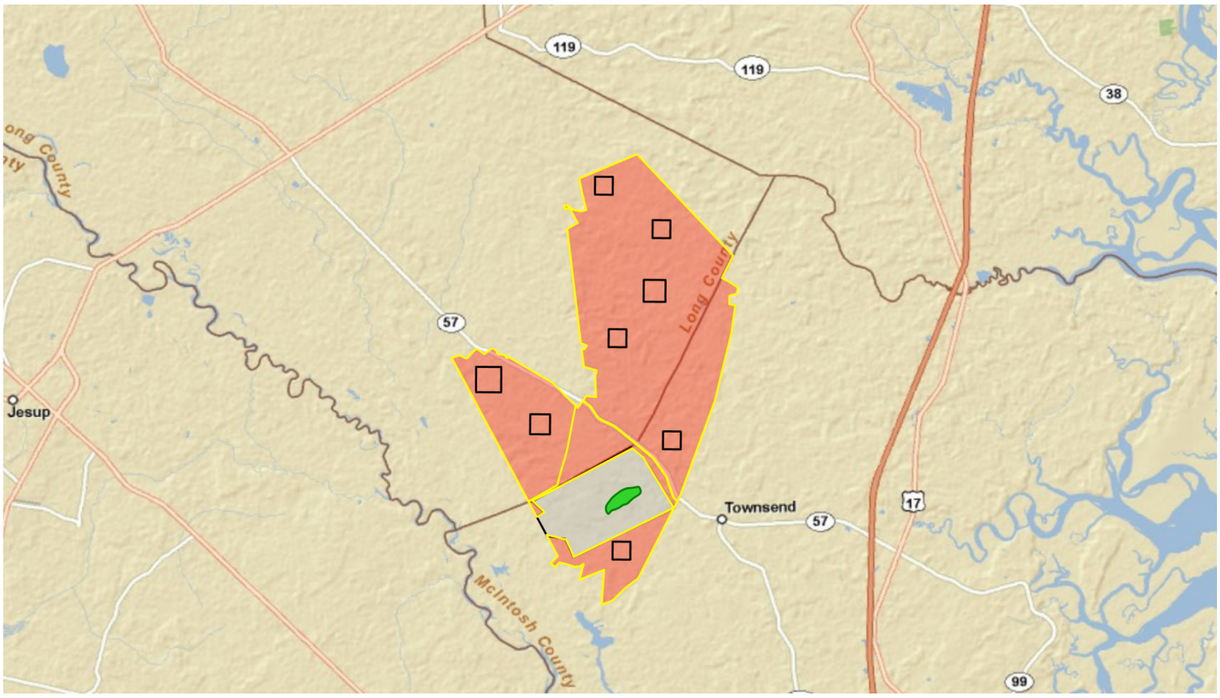

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Figure 4-1. L_{dnr} 55 dBA contour (in green) for current aircraft operations within the TBR/Coastal MOA complex

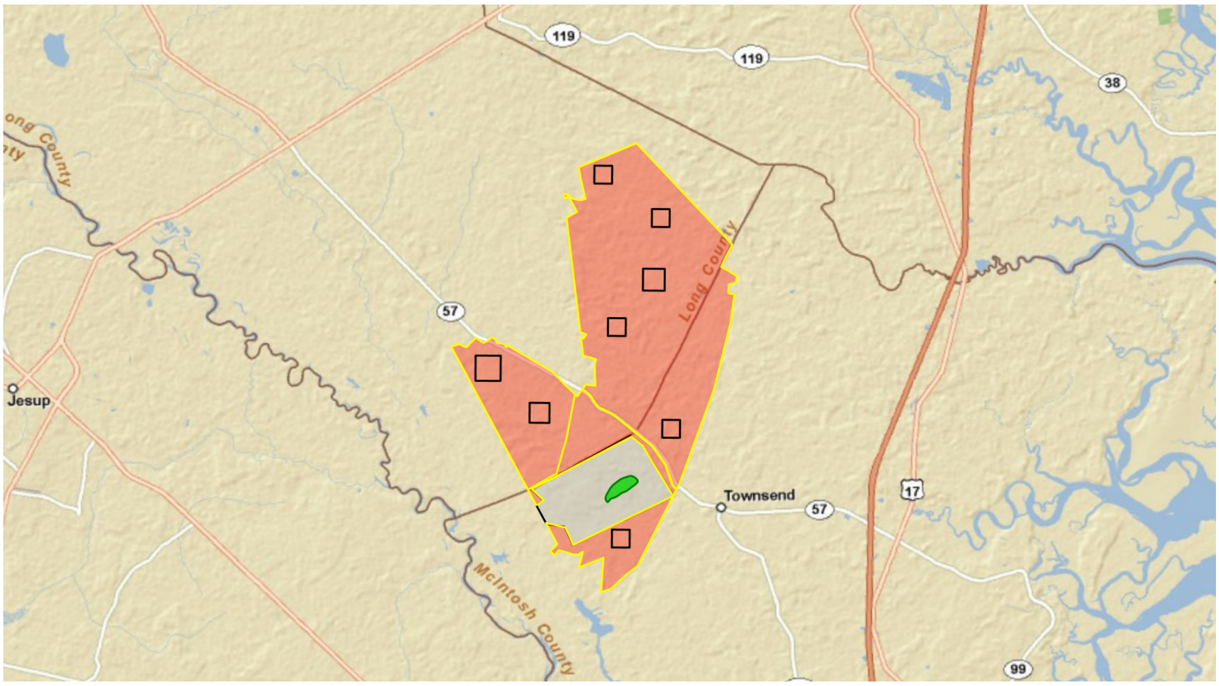

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Figure 4-2. L_{dnr} 55 dBA contour (in green) for Alternative 1 proposed aircraft operations within the TBR/Coastal MOA complex

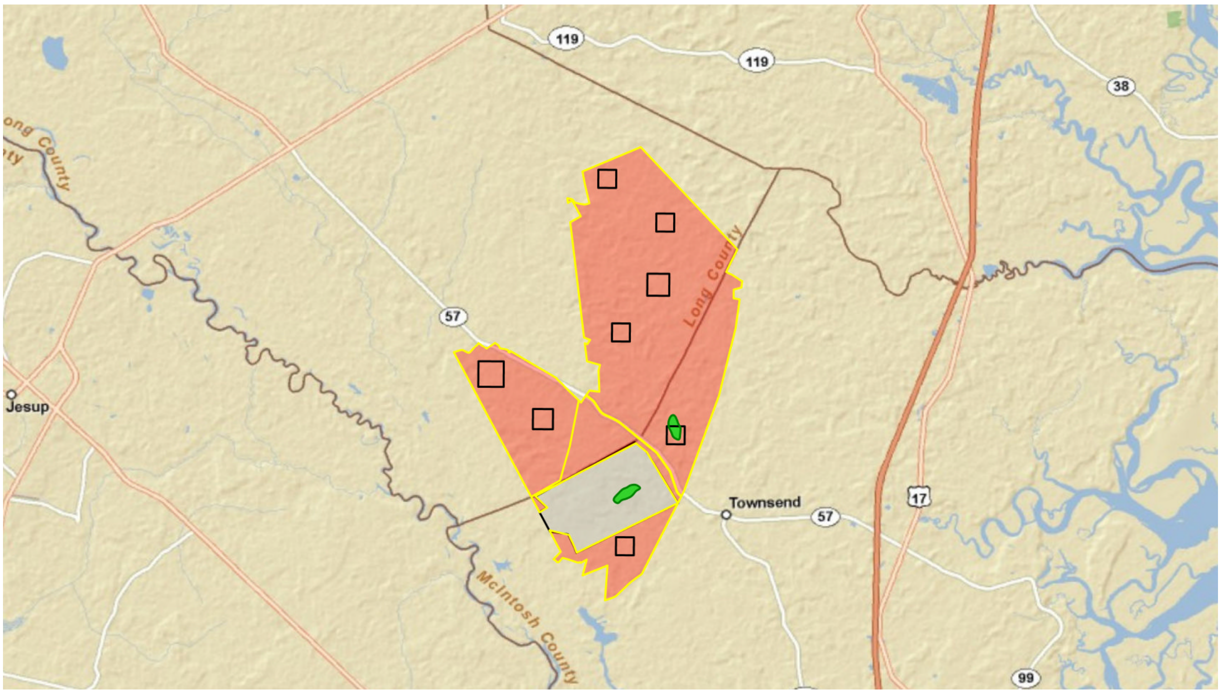

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Figure 4-3. L_{dnr} 55 dBA contour (in green) for Alternative 2 proposed aircraft operations within the TBR/Coastal MOA complex

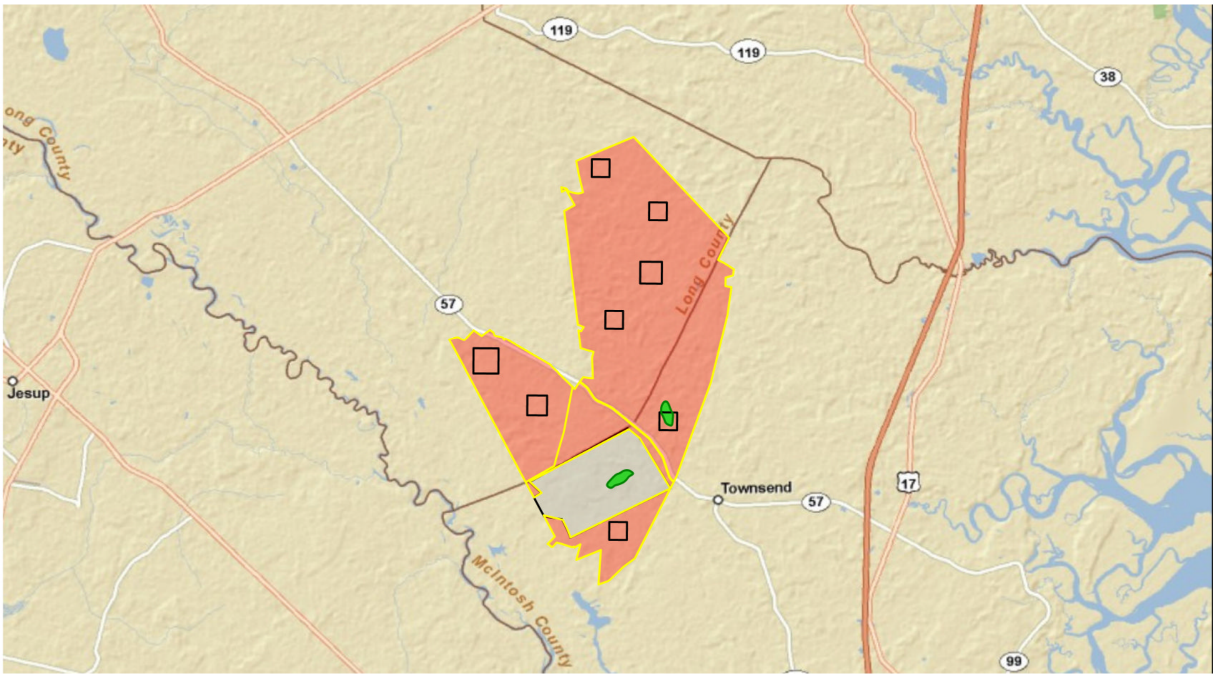

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Figure 4-4. L_{dnr} 55 dBA contour (in green) for Alternative 3 proposed aircraft operations within the TBR/Coastal MOA complex

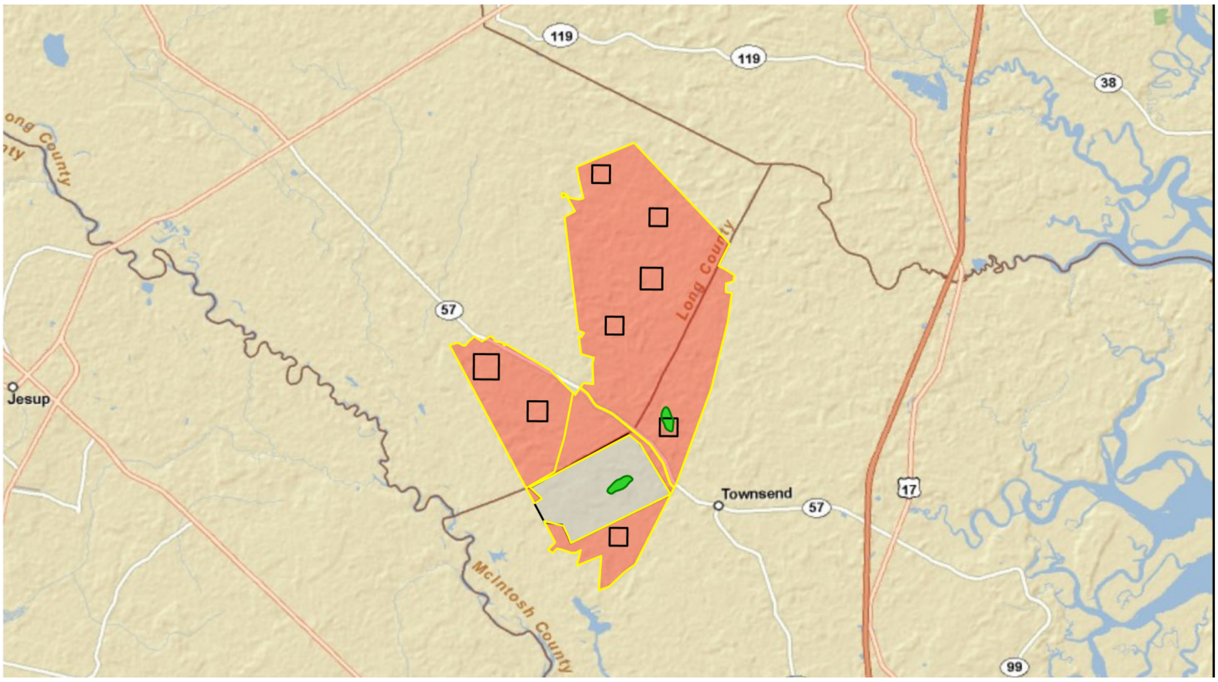

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Figure 4-5. L_{dnr} 55 dBA contour (in green) for Alternative 4 proposed aircraft operations within the TBR/Coastal MOA complex

4.2 Air Gunnery Noise

The Air Gunnery Noise Model was used to develop the noise levels generated by the strafing operations conducted both at the scored strafing pits and by high angle strafing at the Target Areas. These noise events are calculated using the C-weighted L_{dn} (L_{Cdn}) metrics to account for the impulsive nature of the noise as well as the Peak levels (dB_{Pk}) (USA, 2007). Figure 4-6 through Figure 4-10 provide the L_{Cdn} contours for the current operation and proposed alternatives, respectively. These figures demonstrate that the loudest portions of the cumulative air gunnery noise will remain well within the range boundaries (for both current conditions and those proposed). As such, no significant annoyance is expected in the surrounding community for the strafing operations.

Another aspect of air gunnery noise is the potential for noise complaints, which can arise from their impulsive character. The US Army has developed a basic range of peak overpressure levels that may generate complaints from people in the surrounding areas (US Army, 2007). For peak levels below 115 dB_{Pk}, no complaints are expected. For levels between 115 and 130 dB_{Pk}, some complaints may occur. For levels above 130 dB_{Pk}, complaints should be expected. Figure 4-11 through Figure 4-15 provide the composite Peak levels for the range of strafing operations expected at TBR. These contours are not from any individual firing event but from the range of possible firing events at the range. For air gunnery, the primary drivers of the maximum peak levels are the ballistic waves (sonic booms) from the supersonic delivery of the bullets. Peak levels above 130 dB_{Pk} remain within the range boundary. Some outside of the range may be exposed to levels between 115 and 130 dB_{Pk}, which may generate a few sporadic complaints from the surrounding population. Most of the levels going off range are primarily between 115 and 120 dB_{Pk}, which is the lower end of the marginal complaint range.

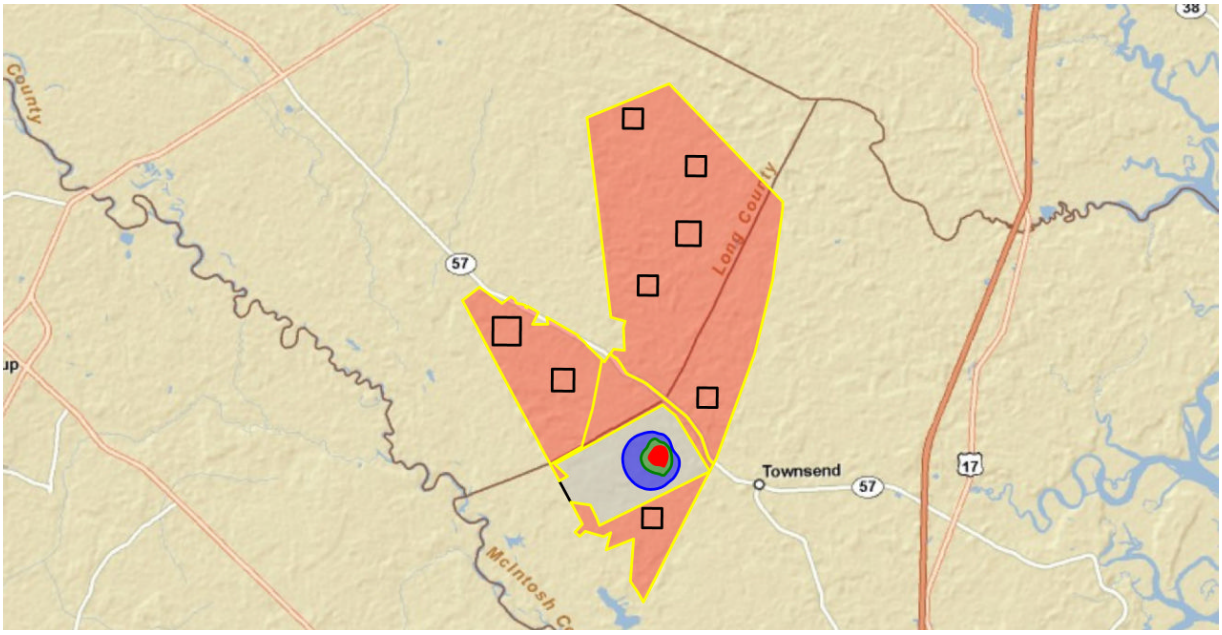

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Figure 4-6. L_{Cdn} contours (57 dBC in blue, 62 dBC in green, and 70 dBC in red) for current air gunnery operations at TBR

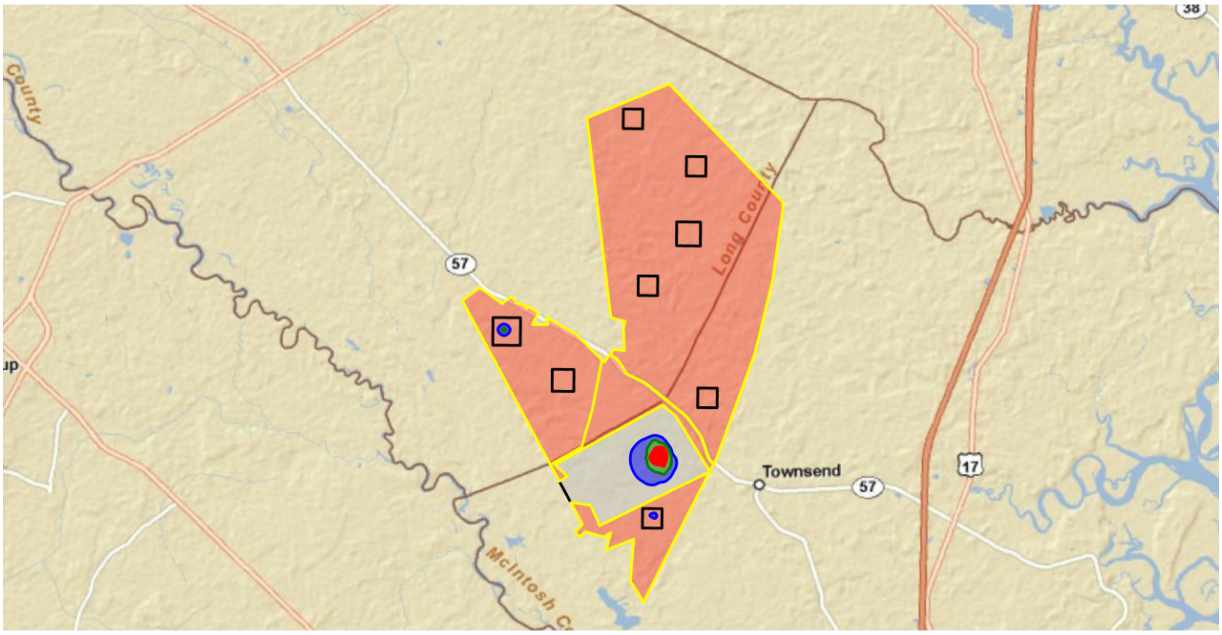

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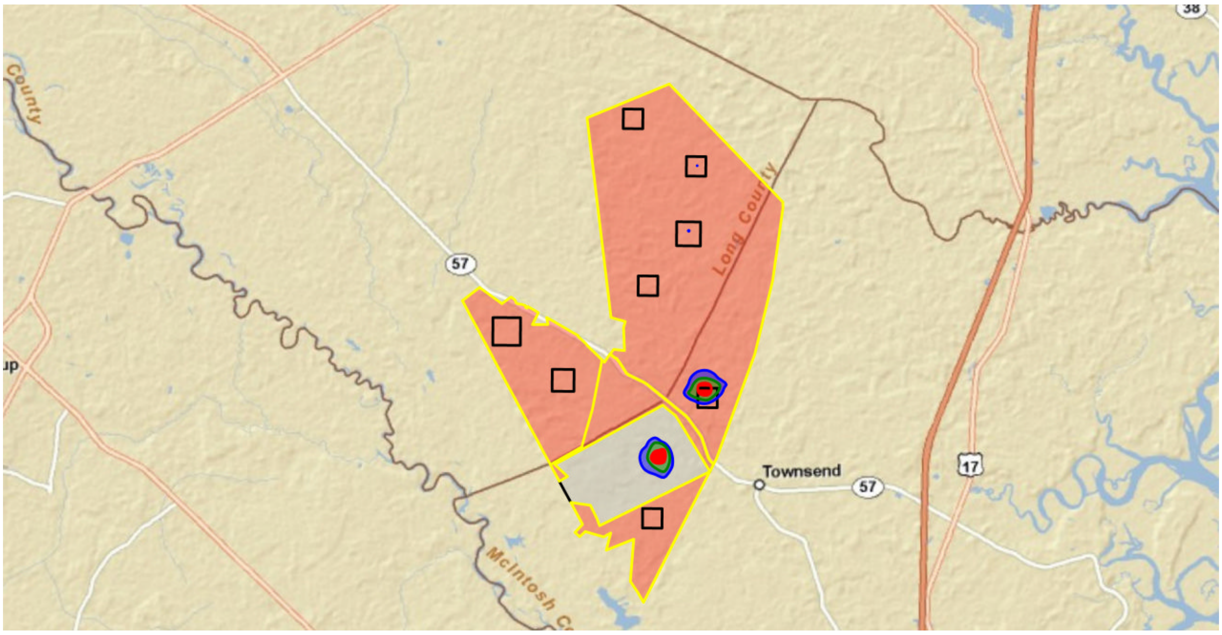
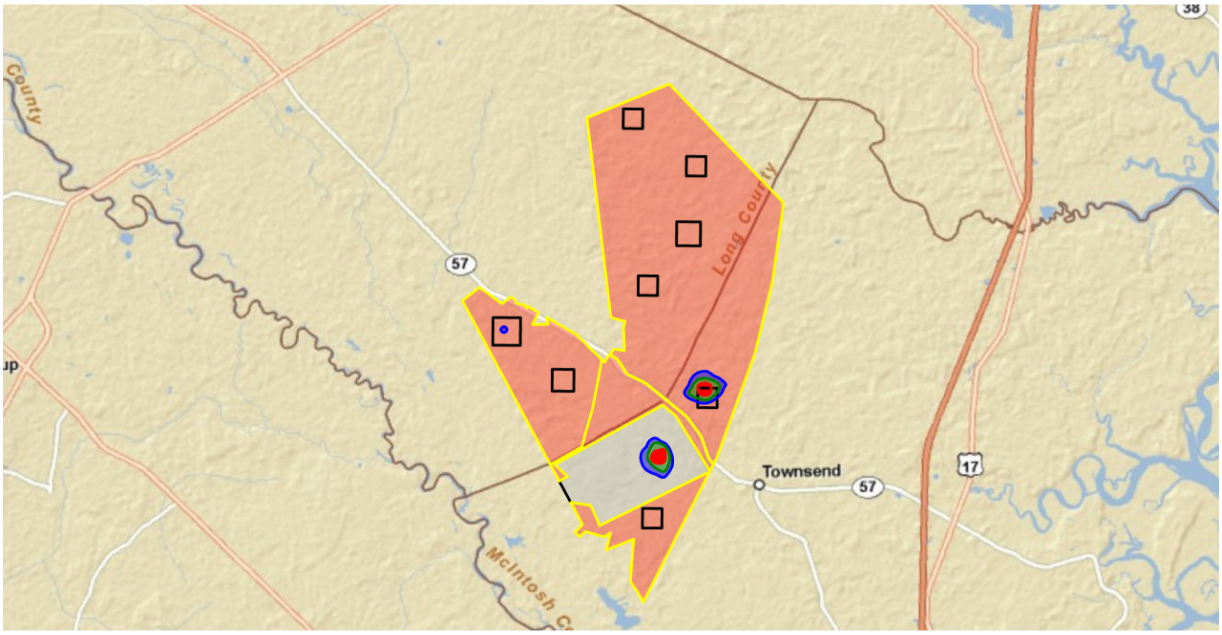
Figure 4-7. L_{Cdn} contours (57 dBC in blue, 62 dBC in green, and 70 dBC in red) for Alternative 1 proposed air gunnery operations at TBR



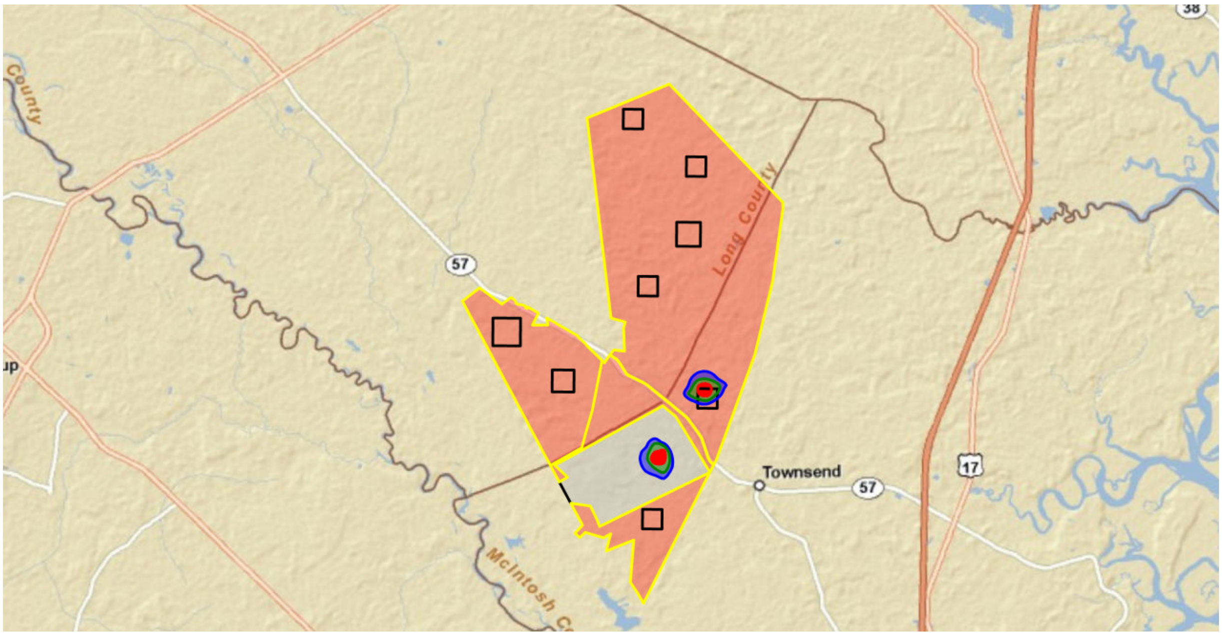
Background map features are not to scale

Figure 4-8. L_{Cdn} contours (57 dBC in blue, 62 dBC in green, and 70 dBC in red) for Alternative 2 proposed air gunnery operations at TBR



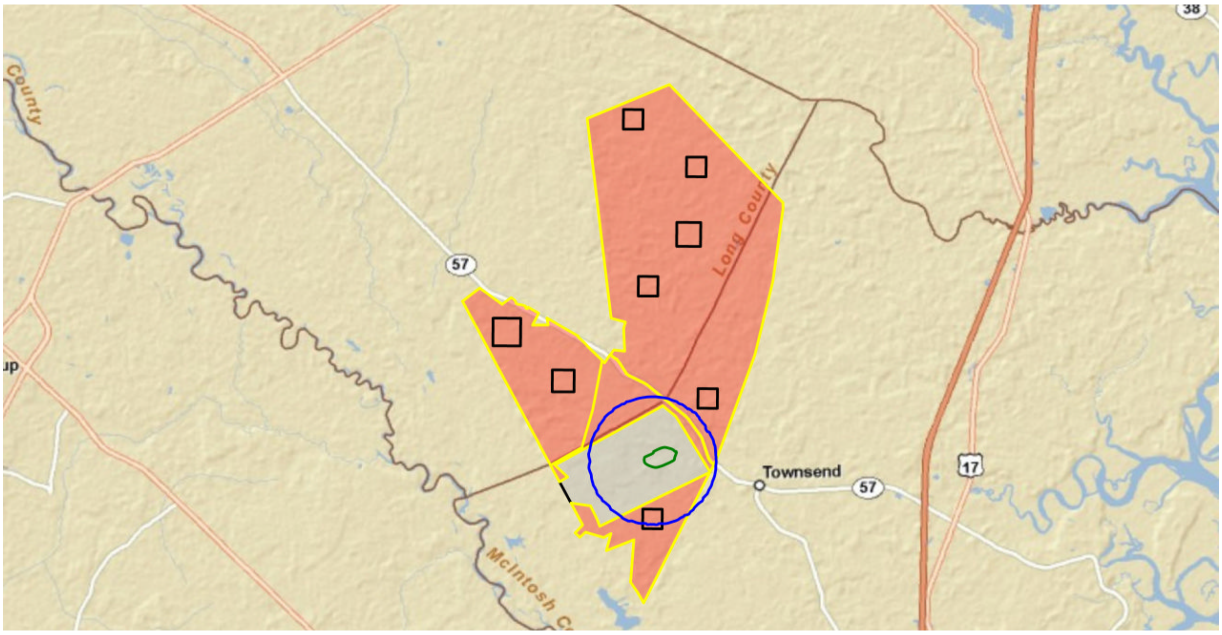
Background map features are not to scale

Figure 4-9. L_{Cdn} contours (57 dBC in blue, 62 dBC in green, and 70 dBC in red) for Alternative 3 proposed air gunnery operations at TBR



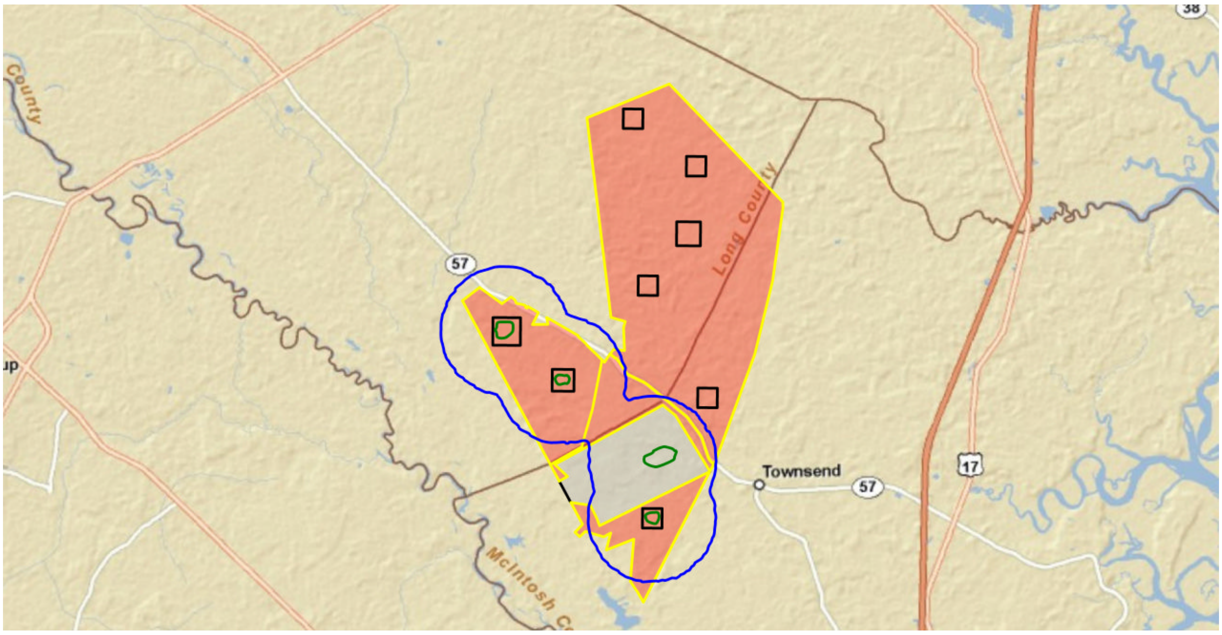
Background map features are not to scale

Figure 4-10. LCdn contours (57 dBC in blue, 62 dBC in green, and 70 dBC in red) for Alternative 4 proposed air gunnery operations at TBR



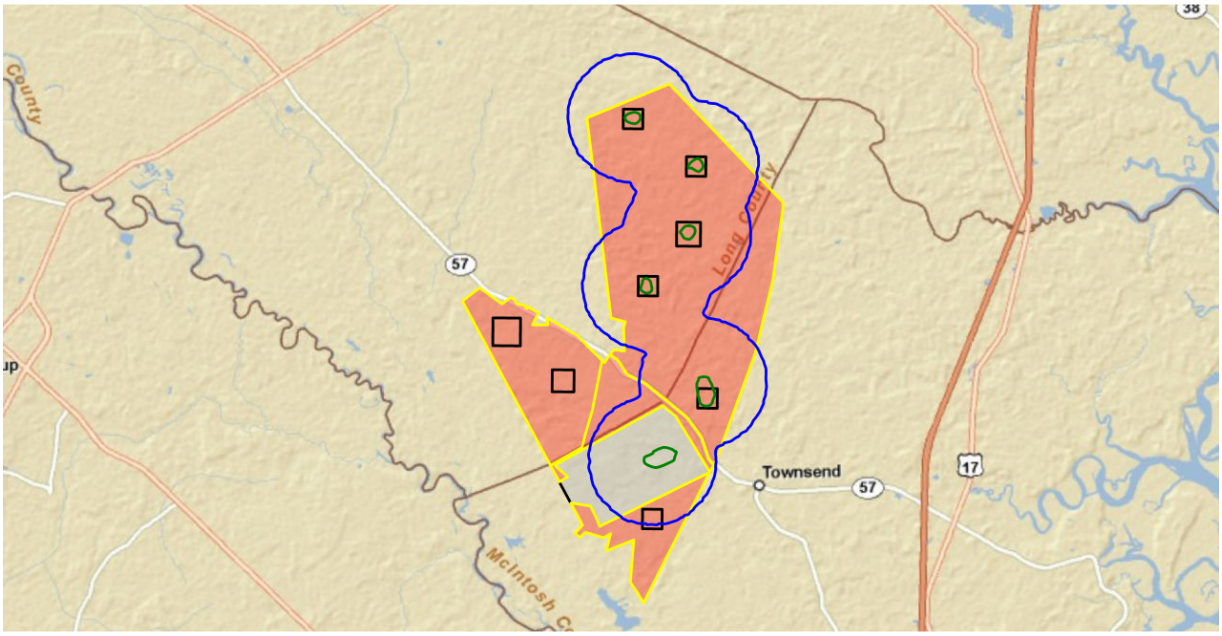
Background map features are not to scale

Figure 4-11. Peak contours (115 dBPk in blue and 130 dBPk in green) for current air gunnery operations at TBR



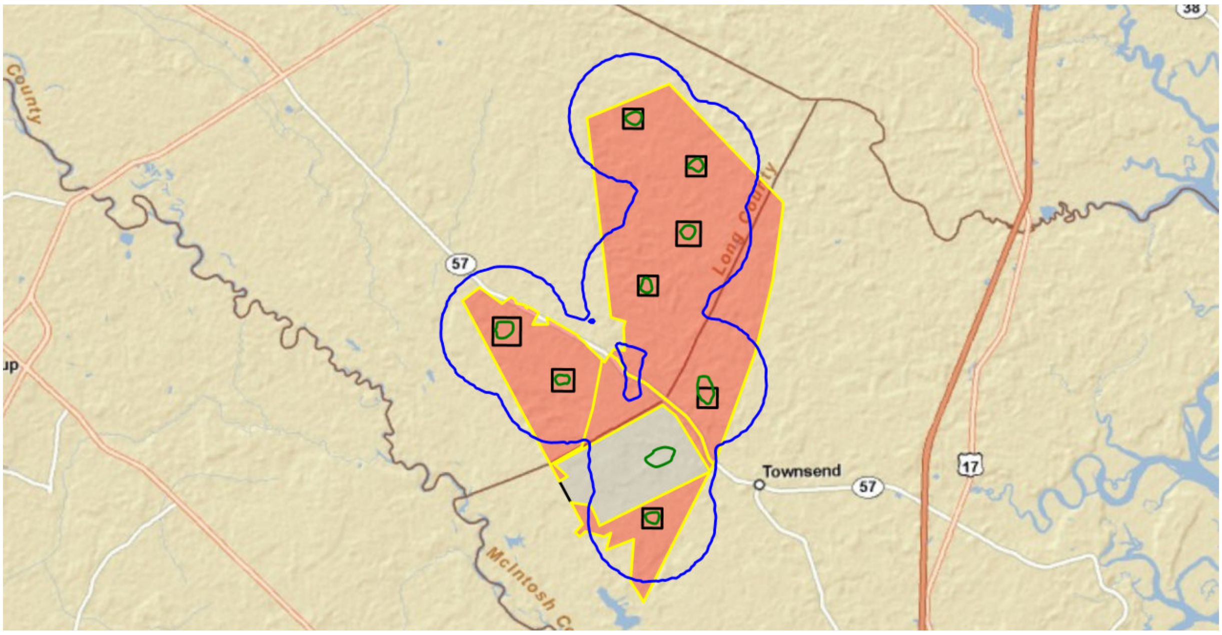
Background map features are not to scale

Figure 4-12. Peak contours (115 dBPk in blue and 130 dBPk in green) for Alternative 1 proposed air gunnery operations at TBR



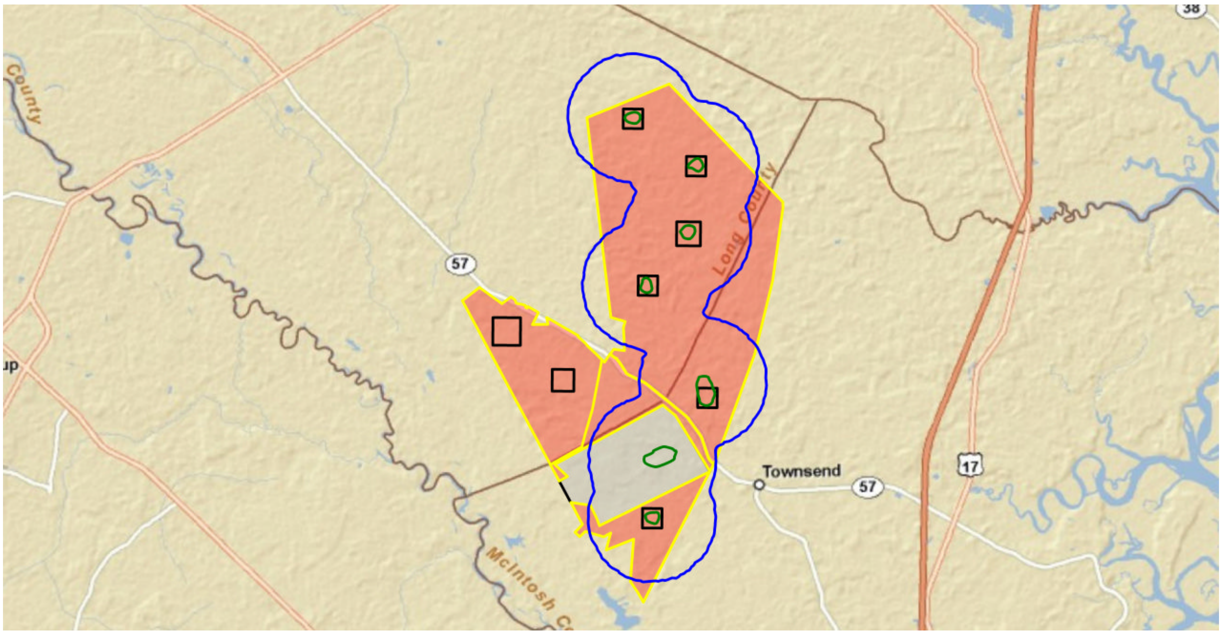
Background map features are not to scale

Figure 4-13. Peak contours (115 dBPk in blue and 130 dBPk in green) for Alternative 2 proposed air gunnery operations at TBR



Background map features are not to scale

Figure 4-14. Peak contours (115 dBPk in blue and 130 dBPk in green) for Alternative 3 proposed air gunnery operations at TBR



Background map features are not to scale

Figure 4-15. Peak contours (115 dBPk in blue and 130 dBPk in green) for Alternative 4 proposed air gunnery operations at TBR

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