FORT MCCOY
INSTALLATION OPERATIONAL NOISE MANAGEMENT PLAN

February 2008

Prepared By:

OPERATIONAL NOISE PROGRAM
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE

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Operational Noise Program
Directorate of Environmental Health Engineering
U.S. Army Center for Health Promotion and Preventive Medicine
Aberdeen Proving Ground, Maryland

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EXECUTIVE SUMMARY

OVERVIEW

The Installation Operational Noise Management Plan (IONMP) provides a review of the current and future noise environment at Fort McCoy. The IONMP provides a methodology for analyzing exposure to noise associated with military operations and provides guidelines for achieving compatibility between the Army and the surrounding communities. The Army has an obligation to U.S. citizens to recommend uses of land around its installations that will: (a) protect citizens from noise and other hazards, and (b) protect the public's investment in the installation.

The noise impact on the community is translated into noise zones. The program defines four noise zones. Zone I is compatible with most noise-sensitive land uses. Zone II is normally incompatible with noise-sensitive land uses. The Land Use Planning Zone provides the installation with a better means to predict possible complaints and meet the public demand for a better description of what will exist during a period of increased operations. Zone III is incompatible with noise-sensitive land uses. These zones exist as noise zone maps within the IONMP.

CONCLUSIONS

Although the training mission on Fort McCoy is diverse, with a wide range of operations, the primary source of noise is generated through large caliber weapons firing and explosive detonations. According to Federal guidelines there are few incompatible uses within the annual average C-weighted (DNL) noise contours for large caliber weapon and detonation activities current or future. However, a moderate risk of noise complaints does exist through predicted peak noise levels for these same operations. Since Fort McCoy receives few noise complaints annually, the recommendations are limited to the following:

Fort McCoy will continue to build its noise management program to:
(1) Reduce potential incompatible land uses around training facilities,
(2) Prevent detrimental effects on the mission, and
(3) Carry on the good-neighbor relationship with surrounding communities.

Fort McCoy will continue to use the program to reduce the potential for noise complaints, caused by day-to-day operations through a responsive noise complaint procedure, and taking actions that are appropriate to guide future development of those properties adjacent to its boundaries. The Public Affairs Office shall remain proactive by informing the public if demolitions operations equal to or greater than forty pounds at any range are to occur, and when future MLRS and Artillery operations resume.

UPDATING THE PLAN

To keep the Installation Operational Noise Management Plan current, it is recommended by USACHPPM that it be reviewed and updated every five years if necessary.

Annual Evaluation. An annual evaluation of the Plan is required to review changes in training/testing and mission, land uses, and local land use planning documents. If changes that have an impact have occurred, an update of the plan is required.

Five-Year Update. Every five years if necessary, it is required that the plan and/or noise contours be updated to incorporate changes in the installation activity and noise environment, as well as changes in the existing or planned land use and economics of the area.

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1.0 INTRODUCTION

1.1 GENERAL

One of the goals of the Department of the Army (DA) is to establish effectual programs designed to minimize the Army's adverse impacts upon the quality of the human environment without impairing continued success in the Army's mission. In keeping with this goal, the Army established an Operational Noise Management Program (ONMP) as the framework for the management of noise produced by Army activities since noise has been determined by the United States Congress, as recorded in the Noise Control Act of 1972, to "present a danger to the health of this Nation's population" (PL 92-574, 1972). The primary tools for noise management are the Installation and Statewide Operational Noise Management Plans.

Note: The Operational Noise Management Plan(s) and Program were referred to as the **Environmental** Noise Management Plan (ENMP) and Program until the name was changed in 2004 in order to better describe the nature of the plan. Older plans, documents, or directives may still feature the word "environmental."

1.1.1 THE HISTORY OF NOISE MANAGEMENT IN THE ARMY

The advent of jet aircraft in the 1950's resulted in significantly greater noise levels around commercial airports that led to an intense outcry from the public. This backlash caused congress to revise the Federal Aid to Airports Act to make Federal aid contingent upon implementation of programs to resolve noise problems with surrounding neighborhoods. Subsequently, Congress passed the Noise Control Act of 1972 and the Quiet Communities Act of 1978. Under these laws, airports and local communities carried out noise control measures such as revising zoning laws, altering real estate transaction requirements, purchasing buffer lands, and changing approach, departure, and run-up protocols. As a consequence, the Federal Aviation Administration (FAA) currently has specific requirements for community involvement in all airport planning.

The Federal Aid to Airports Act exempted military aircraft, as did portions of the Noise Control Act of 1972. However, the Noise Control Act and the Quiet Communities Act did contain language outlining the responsibilities of Federal Agencies in protecting the public from unreasonable noise impacts. Specifically, these laws state that:

> *"Federal agencies shall, to the fullest extent consistent with their authority under federal laws administered by them, carry out the programs within their control in such a manner as to … promote an environment for all Americans free from noise that jeopardizes their health and welfare.*

To comply with the intent of Congress, the Department of Defense (DoD) provided guidance to the military departments regarding the compatible use of public and private lands in the vicinity of military airfields. The DoD guidance (DODI, 1977):

- Defined restrictions on the uses and heights of natural and man-made objects in the vicinity of air installations.

- Defined restrictions on land use in the vicinity of air installations to assure compatibility with the existing characteristics, including noise from military operations.

- Provided policy as to the extent of the U.S. Government's interest in retaining or acquiring real property to protect the operational capability of active military airfields.

As a matter of general policy, the military departments were instructed to work toward achieving compatibility between air installations and the neighboring civilian communities through a compatible land use planning and control process conducted by the local civilian community.

Based upon DoD guidance, the DA then developed its ONMP that addresses noise from all military activities, not just airfields. The Army's program is designed to (U.S. Army, 1997):

- control environmental noise to protect the health and welfare of military personnel and their dependents, Army civilian employees, and members of the public on lands adjacent to Army, Army Reserve, and Army National Guard installations; and

- reduce community annoyance from environmental noise, to the extent feasible, consistent with Army, Army Reserve, and Army National Guard training and materiel testing activities.

1.1.2 THE ENCROACHMENT THREAT

Military installations almost always tend to attract activity from the civilian sector because with government activity come economic benefits. When people arrive to work at these installations, they soon need housing, grocery stores, restaurants, and other support facilities, and businesses crop up to meet that demand. At this point, the relationship between the adjacent town and the installation is in harmony (because one could not exist without the other), and each tend to over-look the other's inconvenient characteristics.

What ultimately can happen is that the town that springs up next to the installation eventually matures and acquires an economic momentum that is independent of the installation. As the town becomes less reliant on the installation as its economic lifeblood, those inconvenient characteristics (such as noise) that were over-looked in the past become less tolerable. New people moving into the area that gain their economic livelihood from areas other than the installation have difficulty understanding that the current location of the town near the installation grew from past ties that have long since been weakened or severed. This, coupled with the fact that increasing populations may also increase the outward sprawl of the town that at its inception originally may have been a comfortable distance away from the installation, ultimately leads to what is known as *encroachment*.

Encroachment is a complicated issue to solve, but an easy one to define. Simply put, encroachment is the process by which civilian issues impinge upon once-remote military installations. The simplest example of this is the physical development (particularly residential) of land directly adjacent to the installation whereby new residents become irritated by installation activities (primarily noise, but things like dust may also turn into contentious issues).

And, while noise is the focus of this plan, encroachment can take many forms. Examples include government entities passing endangered species legislation limiting where training may be conducted; air pollution regulations limiting something like dust; or a form of political encroachment that endangers the training mission when relations between countries shift and installations outside of the U.S. are altered or closed.

The endgame is that these processes can put severe limitations upon the ability of a military installation to support training and for assigned units to maintain an adequate level of readiness. And herein lies the threat as it relates specifically to this plan: as military noise impacts upon the civilian communities increase, so increase both litigation and/or political pressures which could result in degradation of the installation's mission. More specifically, not only does the number of complaints to installation commanders increase dramatically, but so do the number of complaints to elected officials.

One of the best examples of degradation of mission performance due to encroachment occurred at the Naval Air Station (NAS) in Los Alamitos, CA. As is typical of these types of situations, when originally established during WWII, this NAS was in a rural area. But, the post-war expansion of Southern California eventually surrounded it with homes to the point where the Navy could no longer routinely fly its jet aircraft into the property. Today, the Navy has left and the property now serves the California Army National Guard (CAARNG) and the U.S. Army Reserve which, compared to the Navy, operate relatively few noisy flights. In another highly politicized example, citizen outrage in 1999 over the noise and pollution of gunfire on Vieques Island (Puerto Rico) ultimately lead to the Navy's complete withdrawal from the island.

These situations are not limited to the Navy. In the Army's case, encroachment so severely limited the size of the explosives used at Fort Belvoir‘s (Virginia) Combat Engineer field training that it became necessary to move a portion of the training to a less urbanized area at Fort A.P. Hill, VA; but that too was only temporary. In the end, encroachment chased that entire engineer training school all the way to Fort Leonard Wood, MO. In another case, encroachment saddled Fort Dix, NJ with limitations on both the types of weapons that could be fired and the times of day.

A study published by the Army Environmental Policy Institute found that noise was the second most important threat (behind endangered species) to Army Range Operations (AEPI, 1999).

1.1.3 CONTENDING WITH THE THREAT

In all of the above cases, limitations upon operational activities degraded the installations' capability to support essential training, so the training missions on these installations were then moved to other installations. For obvious reasons, this pattern can not continue indefinitely.

The consequences of ignoring the conflicts between the noise generated on military installations and the desires of the civilian community regarding the use of the land surrounding these installations can be grave. If the military fails to respond to the concerns of the civilian community, the ill will produced by such an approach is quite likely to result in estrangement and a general unwillingness within the civilian community to work with the military to formulate creative land use ideas that allow communities and installations to exist in harmony. Worse yet, fomenting ill will can also result in the types of political pressure and lawsuits that force unilateral concessions on the part of the military without any reciprocal concessions from the community.

So in short, in order to prevent the conflicts between military operations and civilian land use from reaching significant proportions, the military (as a whole and individual installations) must take reasonable steps to protect the community from training noise, and it must work with the local governments and land owners to make sure that adjoining lands are developed in ways that are compatible with the noise environment.

1.2 THE ARMY'S OPERATIONAL NOISE MANAGEMENT PLAN

The primary strategies for working with communities to solve issues of noise incompatibility are the creation and maintenance of community-supported long-range planning strategies for adjacent lands, and installation efforts to simply be a good neighbor. This is where the Army's Operational Noise Management Plans are valuable.

The plans come in two formats—statewide (SONMP) and installation-specific (IONMP)—and provide the installation(s) and land use planners with the following things:

- Accurate information needed at the planning table in order to solve encroachment problems including such things as computer-generated noise contour maps, planning strategies, examples of successes and failures at other installations, and basic economic information conveying the value of the installation to the community.

- Strategies for use on the installation(s) to limit, where feasible, the training noise that leaves the installation boundaries including altering training locations, maximizing the noise reduction at existing training locations, and implementing "good neighbor" programs that tailor training times to community needs.

- Guidance on proper complaint management procedures (logging, investigation, follow-up, etc.).

- Guidance on proper public relations procedures to minimize the overall chances of getting a complaint.

Note: These noise plans, while not intended for wholesale dissemination to the public, should be distributed to all applicable regional land use planners and be made available to interested individuals.

1.3 CONTENT

This report is divided into sections detailing the nature of noise, noise metrics and noise management; the overall noise environment for the installation; detailed descriptions of the noise generating activities at various locations within the installation; strategies for addressing current and potential incompatibilities at adjacent lands; and various appendices providing more detailed information on methodologies, definitions, and other similar information.

More detailed information and publications on noise-related topics such as noise-level reduction in home construction, noise sciences, and computer modeling are available directly from the United States Army Center for Health Promotion and Preventive Medicine's (USACHPPM) Operational Noise Program. Please consult our website with questions or for more information:

http://chppm-www.apgea.army.mil/dehe/morenoise/

2.0 NOISE MANAGEMENT

2.1 INTRODUCTION

Army installations are finding with increasing frequency that the land use around their boundaries is becoming incompatible with the noise generated by their training. A combination of factors has contributed to this trend, but it is primarily due to three elements.

First, the United States is in the midst of a relentless expansion of its population. When initially constructed, nearly all of the Army's installations were built in rural areas (unless its purpose was to defend a specific city or place) because it was where the land was cheap, there were few people to disturb, and secrecy could be maintained if needed. But, since 1940 the United States population has grown from 132,000,000 to its current (2007) estimated total of approximately 303,000,000 (U.S. Census Bureau). It is undeniable that all of these additional people must live somewhere, so the populations have been spreading into what were formerly sparsely inhabited areas.

Secondly, advances in technology have created ever more powerful weaponry with ever longer effective ranges. Together with that increasing power and range comes increasing noise and the need for larger and larger areas in which to test and train with them. In the past, when a new weapon was louder than its predecessor, few were around outside of the installation to notice a difference. Today, that is changing.

Lastly, both the military and local planners were late in recognizing the friction that the above two trends would cause. Thus, few plans to ensure compatible land use were made before the problems of encroachment arose.

The consequence is that, at an increasing number of installations, noise complaints are now a regular occurrence and must be managed so as to not jeopardize the training that makes the United States military the best prepared force in the world.

2.2 ENCROACHMENT AND NOISE COMPLAINTS

Noise from U.S. military operations is rarely loud enough to cause physiological and/or physical damage to the hearing or homes of populations adjacent to installation boundaries. Nevertheless, while there is no physical danger from these sounds, many find them irritating to the point where they are moved to complain about them. The complaints can be directed any number of places (friends, local media, government representatives, etc.), but the ideal situation is that the complaint comes to the source (the installation) so that it can be resolved in the best manner possible.

The most reliable way to ensure that this happens is for all installations to maintain the Noise Complaint Management Program required by Army Regulation 200-1 (AR 200-1), a copy of which is located at Appendix F.

2.2.1 THE NATURE OF ANNOYANCE AND COMPLAINTS

Annoyance (and thereby complaints) has its roots in both physical and psychological distress. Since military noise is rarely loud enough to cause physical distress, it follows that the vast majority of noise complaints that installations receive are due to some sort of psychological objection. Put another way, some people just do not like the “cracks” and “booms” and are sometimes irritated enough to complain about them.

The usual complaint pattern is as follows: First, economic activity unrelated to the installation stimulates increased population and development in the vicinity. Next, segments of the new population who are not economically dependent on the installation (or take issue with other aspects of the government presence) find noise to be a specific and undeniable object about which to complain. Finally, the people reporting the complaints become more articulate and eventually address their grievances to higher levels of government, politicizing the issue and endangering the mission.

The amount of annoyance that a particular sound elicits in an individual depends on a combination of many factors. At issue may be the characteristics of the noise itself such as the intensity and spectral qualities; duration; repetitions; abruptness of onset or cessation; and the *ambient noise* climate (or background noise) against which a particular event occurs.

But social surveys show that the following are also factors related to annoyance that have nothing to do with the characteristics of the noise itself:

- The degree to which the noise interferes with an activity.
- The previous experience of the community with the particular noise.
- The time of day during which the noise occurs.
- Fear of personal danger associated with the activities of the noise sources.
- Socioeconomic status and educational level of the community.
- The extent to which people believe that the noise output could be controlled.
- Beliefs about the importance of the noise source.
- General noise sensitivity.
- The amount and effectiveness of noise level reduction (NLR) features in the home.

Some of these the installation can do nothing about. But, others can be molded with carefully focused public relations efforts, and it is these upon which the installation's Public Affairs Office (PAO) should focus.

2.2.2 KEYS TO SUCCESSFUL NOISE COMPLAINT MANAGEMENT

In a nutshell, a Noise Complaint Management Program is the system by which installations plan to deal with issues caused by noise. These issues range from the simple addressing of complaints, to advising local planning commissions, to plans of action to limit the future threat of encroachment. These programs may be administered by a single person at smaller or more remote installations, or an actual noise committee at larger installations or those with significant encroachment concerns. The size and scope of the programs are generally up to the individual installations, but noise should always be given enough consideration so that, due to lack of attention, what are small problems today do not grow into large problems tomorrow.

As stated, Noise Complaint Management Programs can vary from installation to installation based on the characteristics of the noise itself, the size of the installation, and the surrounding population. But, all effective programs share certain elements.

Foremost, all successful Noise Complaint Management Programs are built on the cornerstones of **integrity** and **sensitivity**.

It cannot be emphasized enough that people who lodge complaints must immediately be assured the installation cares about their concerns. This sensitivity to the feelings of complainants immediately helps to get to the root cause of the problem. For instance, many times complainants are less irritated by the noise itself than they are about the fact that it startled them or it interrupted their Sunday brunch. In these situations, simply listening in earnest to the complainant and explaining (to the degree possible given mission security) why the noise was necessary is enough to alleviate the irritation.

Integrity is related to sensitivity in that few people will believe the sincerity of the installation if they feel they are being misled. Consequently, when an installation makes a deal with the public (for instance, that there will be no firing before 0900 on Sundays), the installation must strictly keep its word in order to maintain credibility and the appearance that the installation is meeting the community half-way. This is not to say that the installation can never change procedures; but if it is necessary, it should be explained to the public why **before the change takes place.**

It is these little behaviors that cultivate goodwill and cooperation. Empathizing with the public's concerns creates an environment where information is exchanged more freely, ideas come forth more fluidly, and parties are more likely to make concessions in order to solve problems.

Within the framework of an integrity- and sensitivity-based management philosophy are other proactive tools that can be used to attack the problems of complaints:

Listening

The installation must listen to the community to find out exactly what is annoying them. It is not enough to simply assume that it is the noise. The installations need to find out what it is about that noise—the timing, frequency, a particular vibration, etc.—that is annoying the complainant. Once down to the heart of the matter, the complaint may sometimes be resolved with simple actions.

Informing

Information is the key to combating those factors leading to annoyance listed in the previous section. The more information the installation can provide to the public (without jeopardizing the mission), the more involved they will feel and the less likely they will be surprised by something. Providing the local news media with press releases (including a telephone number or website) when unusual operations are scheduled, or even when normal operations are to resume after a period of inactivity, can go a long way toward limiting complaints. And for their part, the news media must be monitored to ensure that the information is being released to the community in a timely manner. Also, designating a representative to attend community meetings is also an excellent way to keep the public informed and for them to associate a human face with the installation.

Responding

Of course, proactive efforts to establish a reputation for integrity and sensitivity mean little if the complaints the installation does receive are ultimately ignored. Accordingly, it is important to address complaints in a timely and polite fashion to lower the intensity of the situation. When the public is aware that each complaint is responded to quickly and courteously, the potential of the complainants organizing into citizen action groups (that complain to higher levels of command and government) is reduced considerably.

Still, to really understand issues of noise complaints and encroachment, one must first understand the basics of noise itself.

2.3 NOISE AND NOISE ASSESSMENT

Noise is simply unwanted sound.

The “unwanted” part of that definition is of course subjective to the receiver and dependent upon many variables that were touched upon in Section 2.2.1. But, properties of sound have been studied for hundreds of years in a branch of physics called “acoustics.”

Note: This section is a highly simplified discussion. A more detailed discussion of sound is located in Appendix A, and as stated previously, the Army Regulations on operational noise are spelled out in AR 200-1, the noise portion of which is located at Appendix F.

2.3.1 THE SCIENCE OF SOUND

For the purposes of this plan, *sound* is the vibration of air pressure about a mean atmospheric pressure that is usually defined as 100,000 Pascals or 14.7 pounds per square inch (the standard atmospheric pressure at sea level). While all animals have different hearing ranges, these changes in the atmospheric pressure as they relate to human hearing vary from approximately 0.0006 Pascals for a whisper at two meters, to 1,000 Pascals for an M16 rifle at the shooter's ear. It has two basic parts: the energy (i.e., is it loud or soft?) and the frequency (is the pitch high or low?).

Because of this large effective range of sound pressure and the fact that the human ear responds more closely to a logarithmic scale (rather than a linear), the *decibel* system (dB) 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 (the *threshold* of hearing) to 140 for a healthy human hear, though zero is by no means the absence of sound (some people may hear sounds as low as -10 dB). Interestingly, the non-linear characteristics of human hearing means that in the decibel scale, a 3 dB increase is roughly a doubling of sound energy, but it takes a 10 dB increase for something to actually sound twice as loud.

In the same vein, the human ear is not equally sensitive to all sounds in the entire frequency spectrum—it works most efficiently in the medium frequencies where speech is found. Thus, to make a sound measurement more meaningful, scientists have developed processes called *frequency weighting* whereby certain ranges where the ear is more sensitive are factored in more heavily than others where the ear is less sensitive. Consequently, when looking at decibel numbers it is important to recognize whether the measurements are weighted or *peak* (i.e., unweighted).

So, frequency weighting is in effect a type of filtering and, in the context of this plan, the two important filters are *A-weighting* (dBA) and *C-weighting* (dBC). A-weighting is used most often and particularly for higher frequency sounds such as transportation "hum." C-weighting is used for low-frequency events such as large arms and demolition explosions…the things that make a "boom." This weighting becomes important when creating the noise zones discussed later in this section.

Yet, there are other characteristics of sound that are important when determining how a sound becomes a noise. This is where the importance of the means of sound measurement (i.e., by what "yardstick") comes to the forefront.

2.3.1.1 SOUND PROPAGATION

When thinking about mitigation strategies, it should also be kept in mind that there are many factors affecting sound *propagation*, or the how and where of sound travel.

As stated, sound travels through air. So, anything that affects the density or composition of the air, or that interrupts the sea of air between the source and the receiver will have an effect on what sounds that receiver ultimately hears. This is a good news/bad news situation.

The good news is that the creation of physical barriers can do a great deal to reduce the travel of certain kinds of noise. These barriers can be as large as a berm or a wall near the source, or as tiny as a change in the insulation in the home of the receiver, and they can be quite effective at reducing complaints from the public. Due to their smaller wavelengths, physical barriers are most effective against high frequency sounds such as small arms fire and transportation sounds. Low frequency sounds from large arms and explosions have such large waves that they travel over almost anything smaller than a mountain.

The bad news is that one of the greatest influencers of sound propagation is the one over which humans have the least amount of control: the weather. Certain weather conditions can make sound travel for great distances, and others barely at all. Temperature and wind velocity are the prime variables in this phenomena, and the swing at one place between the most favorable and least favorable weather conditions can be as much as 40-50 dB (equating to a 16-32x increase in loudness).

Since sound travels through air, a receiver downwind of the source will be subjected to higher sound levels than a receiver upwind; the breeze is actually helping move the sound to the downwind receiver, but 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.

This makes predicting sound travel tricky, but 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 2-1.

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

Table 2-1 University of Utah Criteria for "Good" and "Bad" Firing Conditions

2.3.2 NOISE METRICS

There are several metrics that may be used to measure sound to make it relevant to a situation. Certainly few people would complain if a plane flew over their house at 15,000 feet once a year at 2:00 in the afternoon. Yet, if that plane flew over a house at 500 feet once a day at 2:00 in the morning, it would be a different story entirely.

So, questions such as "what time?" and "how often?" are just as important as "how loud?" when it comes to making sound measurements meaningful for the purposes of complaint management. The following are the primary metrics that USACHPPM and the Construction Engineering Research Laboratory (CERL) use for measuring military noise (please see Appendix A for more in-depth definitions):

- Equivalent Sound Level (L_{eq}) – Sound exposure "averaged" over a prescribed time period (usually 24 hours).

- Day-Night Level (DNL) – An average like the L_{eq} but with a 10dB "penalty" inflicted on sounds occurring between the hours of 2200 and 0700 (a particularly intrusive time when people are usually sleeping). As discussed above, the DNL may be A-weighted (ADNL) or C-weighted (CDNL) depending on the noise being measured. This average is calculated over a "year," or typically 250 (for active military) and 104 (National Guard) training days.

Note: Since they are based on averages, DNL noise contours (see next Section) grow larger the more shots are fired.

- 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.

- PK15(met) – the peak sound level, factoring in the statistical variations caused by weather, that is likely to be exceeded only 15% of the time (i.e., 85% certainty that sound will be within this range). This exists only in modeling—one cannot take a PK15(met) reading on the ground—and it is used for land use planning with small arms and as additional information for large arms and other impulsive sounds.

  Note: If there are multiple weapon types fired from a particular location (or multiple firing locations), the single event level used to create a noise contour (see next Section) is the loudest level that occurs at each receiver location. As such, PK15(met) contours are the same size no matter how many shots are fired.

- Unweighted Peak – the peak, single event sound level without weighting, on the ground. This measurement takes into account everything from berms, to weather, to the length of the grass—but it is only good for that moment in time under those exact conditions. Consequently, there is no particular confidence built in that the number is reliable in other situations, such as with the 85% certainty built into the PK15 (met) above.

There is no single perfect way to measure noise because different entities have different preferences for what is important. Still, combinations of the above metrics give the clearest picture of a noise environment currently available, and in them most people will find the information they need.

2.3.3 NOISE ZONES

When it comes to land use planning, it isn't enough to have a bunch of numbers. There needs to be a way to use the above-mentioned metrics and represent the results visually on a map so that people can readily see what areas are impacted and to what degree. This is accomplished by employing computer modeling programs to create *noise zones* that, using Geographic Information Systems (GIS), may be overlaid onto maps showing installations, airports, neighborhoods, and the like. Once this is done, it becomes readily apparent which areas in and around an installation are or could be (if improperly developed) exposed to unacceptable levels of noise.

2.3.3.1 NOISE ZONES AS THEY RELATE TO LAND USE

The Army uses a system whereby noise is partitioned into three noise zones, each labeled by Roman numerals and each representing an area of increasing noise. As particular uses such as schools, residences, and churches are more sensitive to noise than other more industrial uses, the zones help to create a picture of where things should be located. Please see Section 9 and Appendix E for more details regarding which uses should be permitted in each noise zone.

Noise Zone I (NZ I)

NZ I includes all areas in which the PK15(met) decibels are less than 87 dB (for small arms), the ADNL is less than 65 (for aircraft), or the CDNL is less than 62 (for large arms and explosions)—it's usually the furthest zone from the noise source, and it is basically all areas not in either of the next two zones. As a rule, this area is suitable for all types of land use.

Noise Zone II (NZII)

This is the next furthest area away from the noise source where the PK15(met) decibels are between 87 and 104, the ADNL is between 65 and 75, or the CDNL is between 62 and 70. The noise exposure here is considered significant and the use of land in this zone should generally be limited to activities such as manufacturing, warehousing, transportation, and resource protection. Residential use is strongly discouraged; however, if the community determines that this land must be used for houses, then the integration of NLR features into the design and construction should be required. Further details of NLR ideas and strategies are available from USACHPPM.

Noise Zone III (NZ III)

NZ III is the area closest to the source of the noise where the PK15(met) decibels are greater than 104, the ADNL is greater than 75, or the CDNL is greater than 70. The noise level in this area is so severe that no noise-sensitive uses should be considered therein.

One final zone is the more informal *Land Use Planning Zone* (LUPZ). This zone is at the upper end of the NZ I and is defined by a CDNL of 57-62 or an ADNL of 60-65. It accounts for the fact that some installations have seasonal variability in their operations (or several unusually busy days during certain times of the year) and that averaging those busier days over the course of a year (as with the DNL) effectively dilutes their impact. Showing this extra zone creates one more added buffer layer to encroachment and it signals to planners that encroachment into this area is the beginning of where complaints may become an issue, and that extra care should be taken when approving plans. Table 2-2 shows all of the noise zones by the respective noise levels.

Noise Zone	Aviation (ADNL)	Small Arms (PK15(met))	Large Arms, Demolitions, Etc. (CDNL)
Land Use Planning Zone (LUPZ)	60-65	N/A	57 – 62
Zone I	<65	<87	<62
Zone II	65-75	87 – 104	62 – 70
Zone III	>75	>104	>70
Legend: > = greater than, < = less than, N/A = not applicable			

Table 2-2 Noise Zone Decibel Levels (AR 200-1)

Again, Army Regulation 200-1 contains the specific regulations governing operational noise. As stated, the noise section of AR 200-1 may be found in Appendix F, and it is a must for any personnel responsible for the creation or mitigation of operational noise to familiarize themselves with this document.

2.3.3.2 THE 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) and it allows military departments to partner with private organizations to establish buffer areas around active installations. These partnerships benefit the citizens of the United States in a number of ways:

- Military readiness is maintained when training days are not lost to encroachment issues.
- Open spaces are protected from development and many times may be used by the public for recreational purposes.
- The military need not buy and maintain more land in order to meet its training needs.
- Critical habitat for threatened and endangered species (TES) is preserved or created.

An example of the success that the ACUB program is capable of garnering can be found at Fort Carson, Colorado. Through good will and cooperation between Fort Carson, the Nature Conservancy and private land owners, Fort Carson was able to put into motion mechanisms to protect its entire southern boundary and a large portion of its eastern boundary from incompatible development, and thus protect the training at its southern ranges.

More information on the ACUB program and other issues of range sustainability can be found at:

http://www.sustainability.army.mil/

2.3.4 THE SPECIFICS OF MILITARY NOISE

The previous section briefly touched on military noise when it introduced the idea of A- and C-weighting for different types of sounds. But, military operations produce several different kinds of sounds that could be construed as noise under the right conditions, and understanding where the noise is coming from is critically important to mitigation efforts by both the installation and the community.

2.3.4.1 SMALL ARMS

The firing of small arms (that is, weapons less than 20 mm) is one of the most common sources of military noise. Given that small arms ranges take up relatively little space, and that all members of the military must qualify at least annually with their weapons, it is little surprise that nearly every installation has at least one small arms range.

The computer model used to create the noise contours for small arms ranges is the Small Arms Range Noise Assessment Model (SARNAM) Version 2.6, and it uses the peak noise level to create noise zones. SARNAM incorporates the latest available information on weapons noise source models, directivity, sound propagation, and the effects of noise mitigation and safety structures such as berms, wall, and ricochet barriers.

For reference, Table 2-3 shows the *unweighted* peak levels (i.e., no filters, and not taking into account any mitigation or safety structures) for an M-16 rifle so that the reader may get a feel for the directivity and distance decay of small arms noise. Note: the 180° azimuth is directly behind the weapon.

Distance (meters)	**Predicted Level, dBP** **Azimuth**		
	0°	**90°**	**180°**
50	135-150	112-127	102-117
100	113-128	106-121	95-110
200	106-121	99-114	89-104
400	93-108	86-101	78-93
800	85-100	77-92	69-84
1600	75-90	67-82	59-74

Table 2-3 Predicted Unweighted Peak Decibels (dBP) for an M-16 (5.56 mm) Rifle

This table is useful in conveying two pieces of information: Firstly, when dealing with small arms ranges, the direction of fire has a large impact on noise levels. Secondly, the impact of a small arms range is relatively localized and thus, under most weather conditions, once a receiver is 1,000 meters from the range (behind the firing line), levels should not be high enough to annoy most people.

2.3.4.2 LARGE ARMS, DEMOLITIONS, AND OTHER IMPULSIVE SOUNDS

The sounds from large arms, demolitions, and other impulsive sounds create the largest complaint issues because the sound can travel so far, it is so difficult to stop, and it can be accompanied by vibration that may increase the public's annoyance.

This type of noise is modeled using the BNOISE2 (Version 1.3) computer modeling program and contours are shown on maps in both the average (C-weighted DNL) and PK15(met) iterations. AR 200-1 states that the CDNL should be used for the purposes of land use planning (Table 2-2). However, members of the public often view "averages" incredulously, so the PK15(met) contours are shown to give an idea with 85% certainty of how loud at any particular location single events are likely to get.

The unweighted peak threshold of physiological hearing damage to the human ear is approximately 140 dBP, but the threshold for annoyance varies greatly among individuals. So, based on the experiences of the Naval Surface Warfare Center (Dalhgren, VA), USACHPPM uses the set of guidelines shown in Table 2-4.

Predicted Sound Level (dBP)	**Risk of Complaints**
<115	Low risk of complaints
115-130	Moderate risk of complaints
>130-140	High risk of noise complaints.
>140	Threshold for permanent physiological damage to unprotected human ears; high risk of physiological and structural damage claims
Note: For rapid fire test programs and/or programs that involve many repetitions of impulse noise, reduce allowed sound levels by 15 dBP.	

Table 2-4 Complaint Risk Guidelines

Pairing these guidelines with the following tables (Tables 2-5 and 2-6) give an example of what noise levels to expect at specific distances, and whether or not those levels have a risk of generating complaints. Again, an azimuth of 180° means that the listener is behind the gun.

Distance (meters)	Predicted Level (dBP) Azimuth		
	0°	90°	180°
500	138-148	137-147	133-143
1,000	127-137	126-136	122-132
2,000	115-127	114-126	110-122
3,000	108-121	107-121	103-116
4,000	103-117	103-116	98-112
5,000	100-114	99-113	94-109

Table 2-5 Predicted Peak Sound Levels for 120 mm Tank Gun Firing

Distance (meters)	Predicted Level (dBP) Azimuth		
	0°	90°	180°
500	136-146	131-141	122-132
1,000	125-135	120-130	111-121
2,000	113-125	108-120	99-111
3,000	106-119	101-114	92-105
4,000	101-115	96-110	87-101
5,000	97-112	92-107	83-98

Table 2-6 Predicted Peak Sound Levels for 155 mm Howitzer Firing

Regarding vibration, studies (Siskind, 1989) have shown that homeowners become concerned about the structural rattling and potential damage when the peak decibels exceed 120 dBP, but actual damage isn't likely to occur at decibels lower than 150 dBP.

2.3.4.3 AIRCRAFT

Aircraft noise is also very common at military installations now that the use of helicopters has become so important in modern warfare, and given the fact that even the smallest installations can employ them (since they do not need space for a runway). So, between classic propeller, jet, and rotary aircraft, the possibilities for aircraft noise complaints are growing.

Several computer models are used to visualize aircraft noise but the most common is NOISEMAP/BASEOPS. Table 2-2 spells out the AR 200-1 ADNL aircraft noise zones used for land use planning.

But, as stated before, the ADNL is just an average; maximum levels are often a good predictor of complaint potential. Thus, the tables below give the expected maximum levels for the most common types of military aircraft (Table 2-7), and the percentage of the population that is likely to be annoyed by particular maximum levels (Table 2-8). Using these two tables can give a rough idea of whether a complaint is likely given specific training parameters.

Slant Distance (Feet)	**Maximum Sound Level by Aircraft Type (dBA)**						
	C-130H[1]	C-17[2]	AH-64[3]	CH-47D[3]	OH-58D[3]	UH-60A[3]	F-16[4]
200	100.2	107.9	91.8	97.5	89.0	91.0	118.7
500	91.5	97.9	83.4	89.3	80.5	82.5	109.7
1,000	84.6	89.2	76.8	83	73.8	75.9	102.4
2,000	77.2	79.5	69.8	76.5	66.7	68.7	94.6
5,000	66.3	66.4	59.1	67.1	56.1	57.8	82.8
10,000	56.9	56.7	49.6	59.1	47.1	48.0	72.5

[1] takeoff power, 170knots; [2] intermediate power, 250 knots; [3] light load, 100 knots; [4] PW-229 engine, intermediate power, 200 knots

Table 2-7 Maximum A-Weighted Sound Levels of Common Military Aircraft

Maximum Level (dBA)	**Percentage Highly Annoyed**
70	5%
75	13%
80	20%
85	28%
90	35%

Table 2-8 Percentage of the Population Likely to be Highly Annoyed by Particular Levels of Aircraft Noise (Rylander 1974)

2.3.4.4 MANEUVER TRAINING AND OTHER TRANSPORTATION

At most installations, noise from maneuver training isn't a problem because the noise from vehicles doesn't travel beyond the distance away from the public that is needed to maintain security. Occasionally convoys or special circumstances can be disruptive, but usually not to the point where it would cause a complaint about noise.

Additionally, maneuver training rarely creates enough noise to create a noise zone contour that can be shown on a map so nearly any adjacent land use is technically compatible (though not always desirable).

2.3.4.5 MISCELLANEOUS

Other sources of military noise include generators, production facilities, research and development facilities, and repair operations. For the most part, complaints from these types of sources are rare and are often resolved at an installation-level.

As with maneuver training, these types of noise producers also rarely create enough noise to create a noise zone contour.

2.4 OPERATIONAL NOISE MANAGEMENT AND MITIGATION

The fact that military training makes noise will not change for the foreseeable future. But, it is possible for both the military and civilian communities to work together for mutual benefit to change how noise is handled.

As has been said previously, noise management on the community's side of the fence is best accomplished through an intelligent, common-sense approach to land use planning next to the installation, entailing a willingness to be creative with how to use the land to accommodate the community's growth needs.

On the military side of the fence, successful operational noise management is generally tackled on two fronts: physical mitigation measures and procedural changes.

2.4.1 PHYSICAL NOISE MITIGATION

Physical mitigation is the idea of putting something in between the source and the receiver, or otherwise orienting the source so that noise is directed away from the receiver to the greatest extent possible. Physical mitigation is best planned for before construction, but it may also be employed after construction in some situations. Examples of physical mitigation are:

- Locating/re-locating ranges relative to natural impediments such as in valleys or behind large stands of trees.
- Constructing artificial berms or enclosing a small arms range within walls and baffles.
- Orienting noise sources toward the interior of the installation property.

As alluded to in the section on propagation (Section 2.3.1.1), the physical mitigation of noise is generally feasible only on the higher frequency sounds such as small arms fire, because the low frequency component of impulsive noise has wave characteristics that make ineffective all but the largest obstacles.

2.4.2 PROCEDURAL NOISE MITIGATION

Physical mitigation of noise (where feasible) should also be coupled with procedural changes that lessen either the noise itself, or the likelihood that the noise will impact the community.

Procedural mitigation includes such steps as:

- Implementing fly-neighborly programs that adjust aircraft training times and routes to lower the impact on the community to the greatest extent possible given mission requirements.

- Adjusting the timing, where feasible, of particularly disruptive activities to avoid conflicts with local events such as church times or holidays.

- Keeping the community informed (when feasible), making public any unusual increases in the intensity of training or if training is to be resumed after a period of inactivity.

- Proper review of Environmental Assessments (EAs) and Environmental Impact Statements (EISs) to ensure that the noise impacts of the proposed actions are addressed and are consistent with the current ONMP.

- Physical monitoring of the noise environment (as opposed to computer modeling) when the noise environment is controversial, when an NZ III exists in a noise-sensitive area, and when a noise is unique and cannot be modeled.

- Incorporating noise contours as a layer on the facilities GIS so that the contours may be combined with other layers (such as land use) and referenced when siting new facilities.

Obviously, efforts at reducing noise impacts through procedural means can only be effective if they are adhered to. As such, the proper training of personnel to consistently obey the noise mitigation procedures that are in place and the instituting of consequences for not complying are vitally important.

2.5 SUMMARY

This section provided the scientific basics of sound itself, the reasons that a sound may become noise, the sources of operational noise, the basics of mitigation, and the big picture of how all of these relate to encroachment and complaints.

Operational noise and development pressures will continue to create the possibility of friction for the foreseeable future. However, sensible planning and the appropriate, timely management of problems can prevent localized pockets of discontent from destroying a mutually beneficial relationship between an installation and its surrounding community.

The following sections will provide the correct noise complaint management procedures, address in detail the specific noise environments at relevant areas, and provide targeted mitigation strategies.

3.0
FORT McCOY AND THE COMMUNITY

3.1 LOCATION

Fort McCoy is located in Monroe County between the towns of Tomah and Sparta and roughly 30 miles east of La Crosse in west-central Wisconsin (Figure 3-1). The installation, which occupies a land area of approximately 60,000 acres, is divided by State Highway 21 south of the cantonment area, which in effect creates a North and South Post. Fort McCoy consists of 1,140 barracks, administrative, dining, and maintenance facilities. More than 45,000 of Fort McCoy's 60,000 acres are available for maneuver and training. The Black River State Forest, Necedah National Wildlife Refuge, Meadow Valley and Sandhill State Wildlife Areas, and various county forests, comprise about 460,000 acres of public lands within a 30-mile radius of Fort McCoy.

3.2 HISTORY

Colonel Robert Bruce McCoy, the installation's namesake, started buying land in the Sparta area for the purpose of eventually becoming an Army installation. By 1905, he had acquired approximately 4,000 acres of land that was sold as part of a 14,000 acre purchase by the Army in 1909 and made into two camps, Camp Emory Upton and Camp Robinson. Field artillery and some infantry units were trained there during World War I through 1918. In 1926, the name was changed to Camp McCoy. In the 1930's, the camp served as a Quartermaster Supply Base for the Civilian Conservation Corps.

Between 1938 and 1942, Camp McCoy added 46,900 acres in preparation for World War II (WWII). Construction for the new Cantonment Area began in 1942 and was completed in the same year. The first unit to train at "new" Camp McCoy was the 100th Infantry Battalion, composed of Hawaiian National Guardsmen. The 100th Infantry battalion fought with distinction up the "boot" of Italy while suffering extremely high casualties. Both Japanese and European prisoners of war were interred at Camp McCoy during WWII. At the end of the war, 247,779 soldiers were processed through the Reception and Separation Center at Camp McCoy.

From 1951 to 1953, Camp McCoy was activated to train soldiers for the Korean conflict. In 1974, the installation was redesignated as Fort McCoy. During the 1980's the Reserve and National Guard mission of Fort McCoy continued to grow, reaching a milestone of training 100,000 soldiers. In 1985, increases in the number of units and soldiers scheduled to mobilize at Fort McCoy gave the post the distinction of being the largest single reserve component center in the U.S. Army (INRMP 2005). In 1990, Operation Desert Storm, supporting Saudi Arabia's response to Iraq aggression became Fort McCoy's primary mission. Mobilization started in August 1990 and continued until March 1991. In total, 74 units from nine states, accounting for nearly 9,000 soldiers processed through Fort McCoy. In 2003, Fort McCoy served in its capacity as one of the Army's 15 Power Projection Platforms. The installation supported mobilization

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missions for eight operations around the globe, and the outlook is for the mobilization mission to continue on an extended basis. From Sept. 11, 2001 through December 2004, Fort McCoy's role as a Power Projection Platform has involved supporting the mobilization/demobilization needs of approximately 30,000 soldiers from 370 units (INRMP 2005).

3.3 MISSION, TRAINING AND ORGANIZATION

Fort McCoy's primary mission is providing for the training and ensuring the readiness of America's reserve- and active-component armed forces. Fort McCoy serves as a Total Force Training Center that annually supports the year round training of approximately 120,000 Reserve, National Guard and active component U.S. military personnel from all branches of the armed services. It is a Power Projection Platform, responsible for deploying Reserve and National Guard component forces in support of contingency operations. Fort McCoy is the only U.S. Army installation in Wisconsin, as well as the only Army facility in the upper Midwest that is capable of providing the full spectrum of individual and collective training for combat, combat service, and combat service support personnel (INRMP 2005).

As previously mentioned, Fort McCoy contains roughly 46,000 acres of maneuver area. Through three land-use agreements, adjacent county and state lands with restrictive access can provide an additional 62,000 acres of training area. When available, these lands include seven parcels of the Black River State Forest, which range from 5,000 to 10,000 acres each, as well as approximately 1,400 acres in Monroe County and approximately 1,000 acres in Jackson County. The use of these lands enhances training by allowing units to use Fort McCoy's maneuver areas to the maximum extent possible to train combat units and use the non Fort McCoy areas for real time/distance training for combat-support and combat-service-support units.

The primary training ranges on Fort McCoy are shown in Figures 3-2 and 3-3. In addition to the ranges, artillery units may use any of 23 standard firing points, or establish non-standard firing points anywhere north of Highway 21. Mortar firing may be conducted from any of 12 established mortar points or from nonstandard firing points with prior approval from DPTMS-Range Operations. The primary ranges for large caliber weapons and demolitions, as well as small arms weapons are listed in Tables 3-1 and 3-2.

Additional training facilities available to units include: two Enemy Prisoner of War Compounds; an Airborne Training Tower; a Swing Landing Trainer; a Hand-to-Hand Combat Pit; a Physical Conditioning Course; three Compass/Land Navigation Courses (mounted and dismounted); a Confidence Course; a Vehicle Recovery Site; two Nuclear, Biological and Chemical (NBC) Chambers; an NBC Decontamination Site; a Precision Driving Course (wheeled vehicles); a Track Vehicle Driving Course; a Rope Bridge Training Site; an Infantry Battle Drill Course; a Bayonet Training Course; a Bayonet Assault Course; an Urban Assault Complex; a Litter Obstacle Course; a rapid runway repair site; a bridging operations site; and two earth-moving engineer sites. A 12-foot rappelling tower is also available for teaching basic rappelling techniques. A 34-and 55-foot towers are used to simulate helicopter, cliff and wall rappelling.

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Range	Type
Range 2A	Multi-Purpose Machine Gun (25mm Gun)
Range 6	Infantry Squad Battle Course
Range 8	Hand Grenade Live Throw Range
Range 11	Light Demolition
Range 17A	Heavy Demolition
Range 26	40mm (Grenade) Machine Gun Qualification Course
Range 29	Multi-Purpose Training Range / Infantry Platoon Battle Course
Range 29A	Anti-Armor (HE)
Range 35	M203 Grenade Launcher Range
Rapid Repair Air Strip	Light Demolition

Table 3-1 Fort McCoy Large Caliber Weapons and Demolition Ranges

Range	Type
Range 1	Automated Combat Pistol / MP Qualification Course
Range 2	Multi-Purpose Machine Gun / Sniper Field Fire
Range 4	Convoy Live Fire
Range 6	Infantry Squad Battle Course
Range 10	Reflex Fire / Rifle Zero Range
Range 12	Light Anti-Armor Range
Range 16	Rifle Zero Range
Range 17	Squad Defense Range
Range 18	Multi-Purpose Machine Gun & Night Infiltration Course
Range 29	Multi-Purpose Training Range / Infantry Platoon Battle Course
Range 30A	Rifle Zero Range
Range 31A	Modified Record Fire Range
Range 32	Modified Record Fire Range
Range 33	Rifle Zero Range
Range 34	Multi-Purpose Machine Gun Range
Range 36	Live Fire Shoot House
Range 41	Urban Assault Course
Range 100	25 meter Multi-Purpose
Range 101	Automated Record Fire / Known Distance
Range 102	Pistol / Shotgun Range
Range 105	Non-Specific Small Arms Range

Table 3-2 Fort McCoy Small Arms Ranges

Aircraft training takes place at the Sparta-Fort McCoy Airport, a joint-use, military/civilian facility, the Young Air Assault Strip, an unimproved tactical landing site which can accommodate aircraft as large as the C-17 and the Rapid Repair Air Strip (RRAS). Fort McCoy contains four airborne drop zones. The Badger Drop Zone can support drops of personnel, bundles and all types of equipment; Warrens Drop Zone can support personnel and bundle drops; and Young Air Assault Strip is used for low-altitude parachute extraction. The Cranberry Drop

Zone is used for special operations. Fort McCoy controls the airspace in two restricted areas, Restricted Area R6901A includes all air space over the installation north of Highway 21 (North Post), and Restricted Area R6901B includes all air space over the installation south of Highway 21 (South Post).

The major training organizations at Fort McCoy are as follows:

- 84th Training Command
- 181st Infantry Brigade, 1st Army East
- 181st Infantry Brigade, 2/411th LSB
- NCO Academy
- RTS Maintenance
- RTS Medical
- Wisconsin Military Academy
- Wisconsin State Patrol Academy

In addition to the training offices on Fort McCoy, there are many tenant organizations serving important roles for Fort McCoy and military activities in nearby states. Tenant organizations located on Fort McCoy include:

- 4/100th Battalion (OD)
- B Company, 6th/52nd Aviation Regiment
- 88th Regional Readiness Sustainment Command
- A Company, 3/339 Logistics Battalion- 7th Brigade 84th Division
- 416th Facility Engineer Center-NW
- Detachment 1, 1152nd Trans Co. (TOM)
- Detachment 1, 6015th Garrison Support Unit
- Army Corps of Engineers Resident Office
- American Federation of Government Employees (AFGE)
- Army Reserve Civilian Personnel Advisory Center
- Army Reserve Contracting Activity - North
- Army Reserve Equal Employment Opportunity Office
- Document Automation & Production Service
- Defense Commissary Office
- Defense Military Pay Office
- Defense Reutilization & Marketing Office
- Equipment Concentration Site 67
- Maneuver Area Training Equipment Site
- Medical Maintenance
- Naval Mobile Construction Battalion-25
- TMDE Support Center
- U.S. Army Reserve Command USAR Pay Center
- USAR/RA RCTG Command
- Veterans Assistance Center

3.4 LOCAL COMMUNITY

As previously mentioned Fort McCoy resides within Monroe County, which has a total land area of 908 square miles and just south of Jackson County in the west-central portion of the State. The county seat is Sparta.

3.4.1 POPULATION

From April 2000 to January 2005 the population in Monroe County increased at a faster pace than in the nation and Wisconsin. The population increased 5.3 percent with the addition of 2,173 residents and ranked 23rd fastest growing among the state's 72 counties. All of the county's five largest municipalities added residents and two of the five grew faster than the overall growth rate for the county. The five largest municipalities together added 1,227 residents, accounting for almost 60 percent of the total growth in the county (DWD 2006). The cities of Sparta and Tomah are the two most populous municipalities within Monroe County. Both also have the highest population densities (residents per square mile) amongst municipalities in the county. Table 3-3 shows the past and present population figures for these areas.

	1990	2000	2006
City of Sparta	7,788	8,648	9,022
City of Tomah	7,570	8,419	8,723
Monroe County	36,633	40,899	43,028
Wisconsin	4,891,789	5,363,675	5,556,506

Table 3-3 Population Statistics (Source: U.S. Census Bureau)

3.4.2 LABOR FORCE, EMPLOYMENT AND INCOME

The labor force participation rate (LFPR) in Monroe County is currently higher than state and national rates. Almost 72 percent of Monroe County residents aged 16 years and older participate in the labor force, compared to 67 and 70 percent for the nation and state, respectively. Table 3-4 shows the labor force data for Monroe County. While the LFPR for Monroe County was higher than the state and national rates, the unemployment rate was lower. Table 3-5 shows a comparison of these unemployment rates for the year 2005.

	2001	2002	2003	2004	2005
Labor Force	22,455	22,644	23,377	23,256	23,675
Employed	21,435	21,545	22,210	22,276	22,715
Unemployed	1,020	1,099	1,167	980	960
Unemployment Rate	4.5%	4.9%	5.0%	4.2%	4.1%

Table 3-4 Monroe County Civilian Labor Force Data
(Source: DWD, Bureau of Workforce Information)

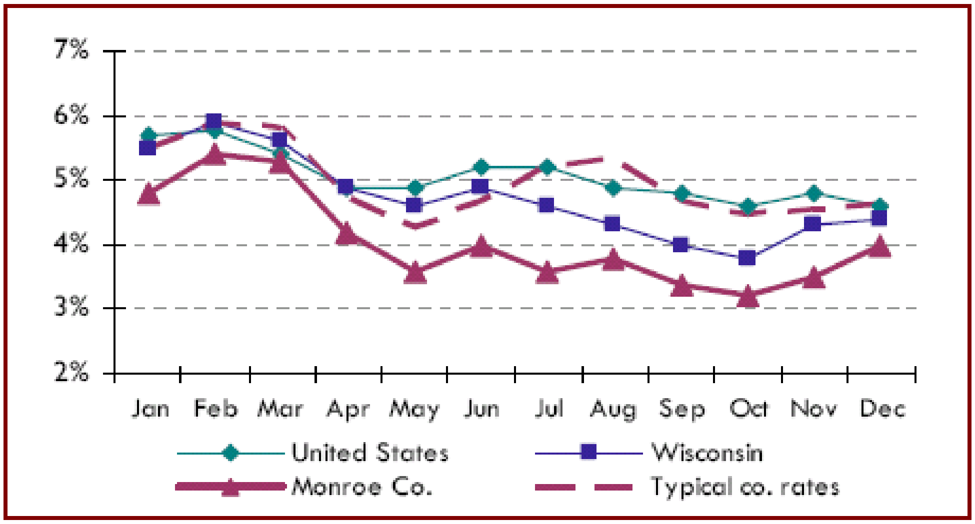


Table 3-5 2005 Unemployment Rates Comparison
(Source: DWD, Bureau of Workforce Information)

There are over 60 manufacturers located within 10 miles of the Interstate corridor (Highways 90 and 94) in Monroe County centered primarily around the City of Sparta and the City of Tomah. Some of the more prominent industry clusters in terms of number employed and total sales in the County include: 1) Food Processing; 2) Metal Products; 3) Machinery, Equipment and Electronic Products; 4) Plastic Products; and 5) Miscellaneous Manufacturing.

In addition to Fort McCoy, government employment for the veteran's hospital, schools districts, and local governments appear on the prominent employer's list for Monroe County. It is not unusual for school districts and government to be included among the largest employers in a county as well as among prominent employing industries. Government and public schools serve a large segment of the county's population resulting in a large concentration of employment with a single or few employers (DWD 2006). The main or prominent employers in Monroe County are listed in Table 3-6.

Establishment	Service or product	Number of employees (Dec. 2005)
Wal-Mart	General warehousing & storage	1000+ employees
Fort McCoy	National security	500-999 employees
Northern Engraving	Motor vehicle metal stamping	500-999 employees
Department of Veterans Affairs	Psychiatric & substance abuse hospitals	500-999 employees
Toro Mfg	Farm machinery & equipment manufacturing	500-999 employees
Cardinal Glass Industries	Glass product mfg. made of purchased glass	500-999 employees
County of Monroe	Executive & legislative offices, combined	500-999 employees
V T Griffin Services	Facilities support services	500-999 employees
Tomah Public Schools	Elementary & secondary schools	500-999 employees
Sparta Area School District	Elementary & secondary schools	250-499 employees

Table 3-6 Prominent Public and Private Sector Employers in Monroe County
(Source: DWD, Bureau of Workforce Information. *Fort McCoy figures represent Garrison employees only.)

Per capita personal income (PCPI) is the result of dividing an area's total personal income (TPI) by its total population. Total personal income is gathered by the Bureau of Economic Analysis and includes income from three major components: net earnings; dividends, interest, and rent (property income); and transfer receipts. The dynamics of the three components impact total personal income, and TPI and population are integral in determining an area's PCPI (DWD 2006).

Net earnings in Monroe County comprise 68 percent of TPI compared with 70 percent in the state and nation; however, the percent change in net earnings in Monroe County increased at a faster pace than the state over both the one-year and five-year time frames. Net earnings in Monroe County increased by nine percent and 34 percent over the one-year and five-year time periods respectively, compared to six percent and 25 percent statewide. Table 3-7 illustrates the per capita and personal income statistics for Monroe County.

	Total Personal Income (TPI) (in thousands)			Per Capita Personal Income (PCPI)		
	2004	2003	1999	2004	2003	1999
Monroe	$1,063,007	$987,882	$830,915	$25,161	$23,686	$20,496
Wisconsin	$177,026,243	$167,785,798	$144,702,139	$32,166	$30,664	$27,135
United States	$9,705,504,000	$9,157,257,000	$7,796,137,000	$33,050	$31,484	$27,939
Percent Change		1-year	5-year		1-year	5-year
Monroe		7.6%	27.9%		6.2%	22.8%
Wisconsin		5.5%	22.3%		4.9%	18.5%
United States		6.0%	24.5%		5.0%	18.3%

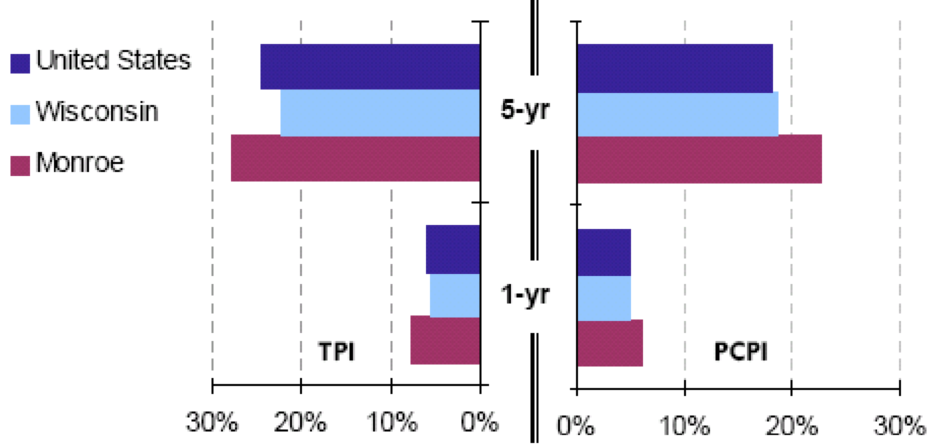


Table 3-7 Per Capita Income and Personal Income for Monroe County
(Source: U.S. Dept. of Commerce, Bureau of Economic Analysis, 2006)

3.4.3 FORT McCOY ECONOMIC IMPACT

The operations at Fort McCoy generate substantial revenues to local economies through wage and salary payments to military and civilian employees, operating costs such as rent and lease payments for various types of equipment, utilities, telephone, office supplies, as well as construction contractor payments and other prime contract awards. In fact, the Fort McCoy Plans, Analysis and Integration Office estimates the installations total economic impact nears $900 million dollars. Table 3-8 below summarizes the economic impact and shows this total:

I. Dollars returned to the economy			**$280.4 million**
A. Work force payroll		**$ 88,630,445**	
Civilian	$ 63,981,180		
Military	$ 24,649,265		
B. Operating costs		**$180,815,034**	
(Includes costs for utilities, physical plant maintenance, repair and improvements; new construction projects; and purchases of supplies and services.)			
C. Other expenditures		**$ 10,928,056**	
Revenues to local governments *(Includes land permit agreements and school district impact aid.)*	$ 161,256		
Soldier discretionary spending *(Based on training population during FY 06)*	$ 10,766,800		
II. Total estimated economic impact			**$897.3 million**
(A Gross Multiplier Index (GMI) of 3.2 was used to calculate this estimate. The GMI reflects how many times a dollar turns over within this region.)			

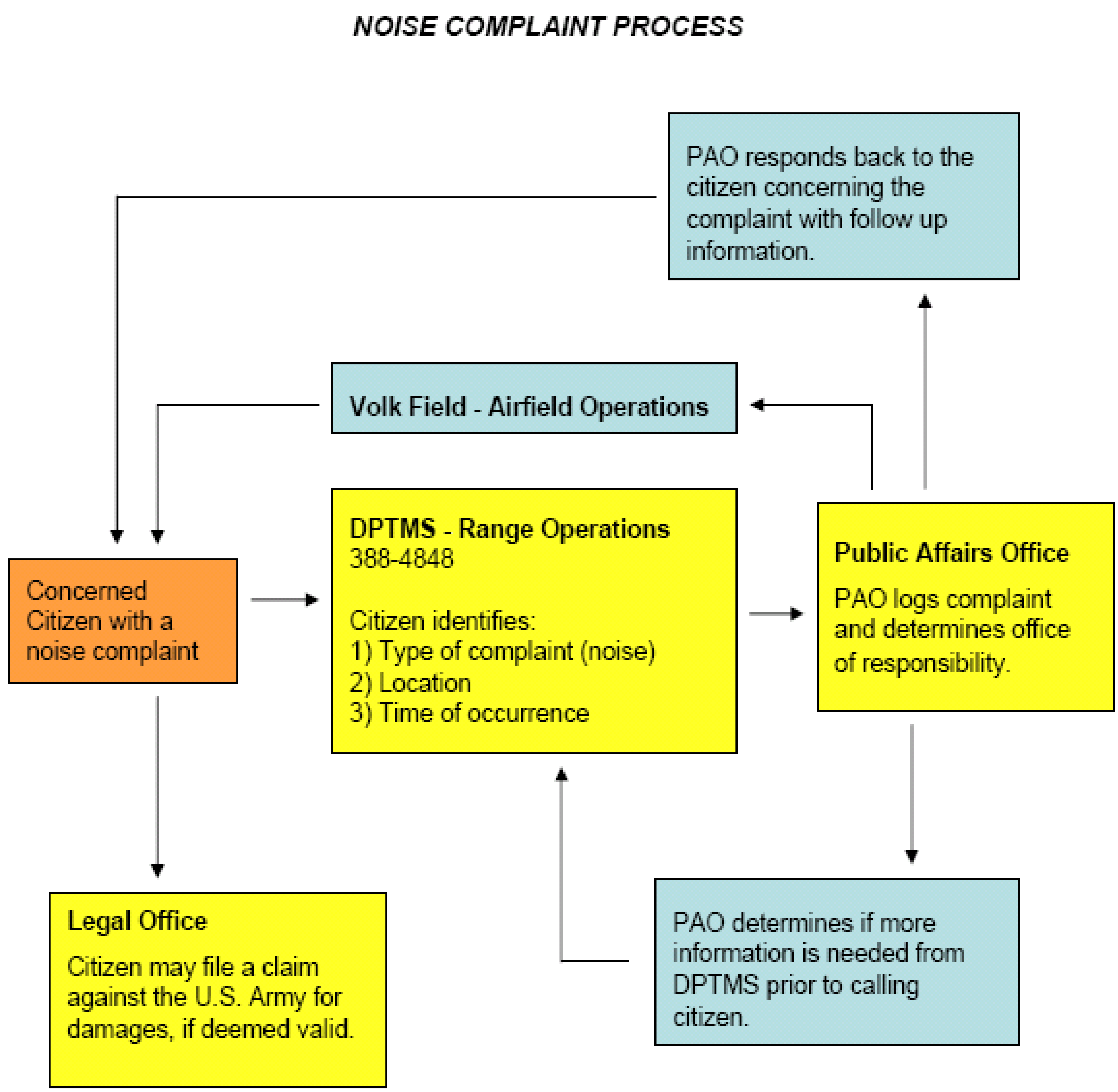
Table 3-8 Fort McCoy Economic Impact

These statistics are contained in the installation's FY 2006 Economic Resource Impact Statement, which covered the fiscal year that ran from Oct. 1, 2005 through Sept. 30, 2006. The total expenditures and economic impact of Fort McCoy have been increasing steadily since FY 2001 when expenditures were $145.3 million and the economic impact was $334.1 million. A GMI of 2.3 was used before FY 2004. More than 3,400 personnel were in the Fort McCoy work force in FY 2006. This included 1,460 civilian employees, 550 military personnel and 1,400 contracted employees.

3.5 NOISE COMPLAINT MANGEMENT

In accordance with Army Regulation (AR) 200-1, Fort McCoy has implemented a noise complaint management program. The following diagram is the Fort McCoy Noise Complaint

Process which was developed to provide a standardized complaint procedure for all responsible Fort McCoy staff:



In recent years the number of noise related complaints has reduced significantly. Fort McCoy averages only two complaints per year. In addition to handling complaints the Public Affairs Office maintains an active public relations program for noise and will submit press releases to local media on a regular basis concerning noise and training tempo. As discussed in Chapter two, a successful noise complaint program can establish a positive rapport with local communities, which ultimately protects the training mission of the installation.

3.6 SUMMARY

This section provided general information pertaining to Fort McCoy's structure, local communities and noise management program. The following sections will provide an assessment of the noise generated by training operations on Fort McCoy and their impacts on the surrounding environments.

4.0
FORT McCOY NOISE MANAGEMENT

4.1 GENERAL

The principal sources of noise on Fort McCoy are generated through small arms firing, large caliber weapons firing and explosive detonation activities, and aircraft utilizing the joint use Sparta-McCoy Airport. The following discussion is divided into two separate sections. The first is the current noise environment, dealing with the existing or baseline operations at Fort McCoy. The second is the future noise environment, which deals with additional forecast operations post-deployment, as well as any new proposed range facilities on Fort McCoy.

Since there are multiple training activities occurring at any given time on Fort McCoy, all of which have the ability to generate substantial noise, it is prudent to evaluate the sum of these activities rather than the individual parts. In effect, this provides a "worst case scenario" for all firing operations on the installation. Therefore, all noise contours modeled for the Fort McCoy are for combined training operations unless stated otherwise.

4.2 CURRENT NOISE ENVIRONMENT

The following discussion deals with conditions that currently exist within the areas around Fort McCoy, pertaining to compatible and incompatible land uses. The Federal guidelines pertaining to compatible and incompatible land use around military installations have been addressed briefly in other parts of the plan. By determining the locations of the noise zones and applying the Federal guidelines to these zones, present and future land use can be evaluated as to acceptability for various types of activities.

4.2.1 SMALL ARMS NOISE

A brief discussion of small arms firing in chapter two states that the "impact of a small arms range (i.e. live-fire) is relatively localized and thus, under most weather conditions, once a receiver is 1,000 meters from the range (behind the firing line), levels should not be high enough to annoy people". Although the majority of small arms ranges on North Post are located to the interior of the installation, where noise from firing has a negligible effect, there are several ranges located close to the western boundary which warrant analysis.

The combined peak level noise contours for small arms are illustrated in Figure 4-1. The Zone III noise contours are contained within the installation boundary. The Zone II contour extends beyond the boundary west of Ranges 16 and 17; however there does not appear to be any incompatible land uses within the contour. Thus, the 1,000 meter rule seems to be in effect, and although these ranges are close to the installation boundary they are compatible with Federal guidelines.

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Of the small arms ranges on South Post, currently only two are used with regularity (Range 101 and 102), with improvements scheduled for Ranges 100 and 105. Figure 4-2 illustrates the peak level noise contours for the current ranges operating on South Post. The Zone III noise contour extends beyond the boundary just north of Range 102 and south of Interstate 90. There are no incompatible land uses within the Zone III contour. The Zone II noise contour also extends to the northwest, as well as southwest and southeast off the installation boundary. Several structures are contained within the Zone II noise contour.

To generate contours using SARNAM, specific firing point and target point locations must be entered into the program. At a Military Operations in Urbanized Terrain (MOUT) facility, there are no set firing point or target point locations; firing can occur at multiple locations and in multiple directions of fire. Therefore, noise contours for activity at MOUT and similar ranges can not be modeled using SARNAM.

The Convoy Live-Fire Range (4), the ISBC (Range 6), and the Urban Assault Course (Range 41) on Fort McCoy fall into this category, thus they were excluded from the contours in Figure 4-1. However, by looking at the predicted peak levels for an M-16 blank round in Table 4-1, the M-16 live round in Table 4-2 and the 9mm and .40 Cal pistols in Table 4-3, we can see how far noise approaching Zone II levels [PK15(met) 87 dBP] would extend out at different azimuths. Taking the loudest direction of fire (0^o) into account the Zone II noise contour would be expected to extend 200 meters, 1600 meters, and 800 meters respectively for each type of weapon/ammunition. It's important to remember that for a "live-fire" weapon, Safety Danger Zones (SDZ) must still be adhered to, thus the zero degree azimuth may not apply when close to the installation boundary. By comparing these numbers to the utilization chart in Appendix B.1.2 it can be said with reasonable certainty that the 87 dBP level extrapolated out would remain within the Fort McCoy boundary for all three ranges.

	Predicted Level, dBP Azimuth		
Distance, meters	**0^o**	**90^o**	**180^o**
50	94-104	**92-102**	92-102
100	87-97	86-96	87-97
200	80-90	79-89	80-90
400	69-79	68-78	69-79
800	60-70	59-69	60-70

Table 4-1 Predicted Peak for M-16 BLANK Round

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	Predicted Level, dBP Azimuth		
Distance, meters	0°	90°	180°
50	140-150	112-127	107-117
100	118-128	111-121	100-105
200	111-121	104-114	99-104
400	98-108	91-101	83-93
800	90-100	82-92	74-84
1600	80-90	72-82	64-74

Table 4-2 Predicted Peak for M-16 LIVE Round

	Predicted Level, dBP Azimuth		
Distance, meters	0°	90°	180°
50	114-124	109-119	105-115
100	108-118	103-113	99-109
200	102-112	96-106	93-103
400	91-101	84-94	83-93
800	83-93	76-86	75-85

Table 4-3 Predicted Peak for 9mm and .40 Cal Pistol

4.2.2 SIMULATORS

Simulator noise levels will vary depending on the type (i.e. artillery, ground burst, and grenade), but as general rule artillery simulators are two to three decibels higher than a grenade simulator. Table 4-4 gives an approximation of artillery simulator noise levels that would be anticipated under average weather conditions and under weather conditions that favor sound propagation. The levels were generated using the BNOISE2 computer program, and then verified by comparing the levels with results from various noise monitoring studies (U.S. Army 1983, U.S. Army 1984, U.S. Army 1989).

Based on the levels in Table 4-4, it can be inferred that under average weather conditions, the risk of complaints (115 dB) will be low beyond 500 meters. Under bad weather conditions, such as during a temperature inversion, or when there is a strong wind blowing in the direction of the receiver, the distance increases to approximately 800 meters. Therefore, guidance for units training with simulators on Fort McCoy would be to remain at least 800 meters from the installation boundary or closest sensitive land use.

Distance from source (meters)	Average Weather Conditions (PK50(met))	Bad Weather Conditions (Pk15(met))
100	134	136
200	125	130
300	120	127
400	117	123
500	114	121
600	111	118
700	109	116
800	107	114

Table 4-4 Predicted Peak Noise Levels for Artillery Simulator

4.2.3 LARGE CALIBER WEAPONS AND DEMOLITION NOISE

As previously mentioned, Army Regulation (AR) 200-1 defines noise zones and recommended land use guidelines for large caliber weapons noise using both the C-weighted DNL (CDNL) metric and the PK15(met) noise metric (Appendix F). The CDNL metric is effective for land use planning, as the CDNL is an average which shows exposure over a period of time (generally CDNL contours are averaged annually). However, experience at Army installations has shown that *complaints* from large caliber weapons and demolition training/testing are usually attributed to a single loud event, at a particular point in time, versus the average noise dose received at any one location. Often complaints are received from areas that are considered “acceptable” with the noise environment using the CDNL metric. To this end, the Army has adopted the practice of assessing large caliber weapons noise using both the CDNL and the PK15(met) metrics.

The CDNL noise contours for the existing or baseline combined operations are shown in Figure 4-3. These contours are based on 2006 ammunition expenditure data (Appendix B.2.1), and include all operations averaged over 104 days. The Zone III noise contour is almost entirely contained within the installation boundary, with the exception of a small area southwest of Range 17A along the western boundary. The Zone II noise contour extends beyond the installation boundary to the west and a small portion east of FP 412. The LUPZ extends beyond the boundary in several points along the eastern boundary, north of the RRAS, and the western boundary. There are no incompatible land uses contained within the Zone III or Zone II contours.

Modeling the training facilities using PK15(met) metric provides a better means to assess the *risk* of noise complaints. The unweighted peak threshold of physiological hearing damage to the human ear is approximately 140 dBP, but the threshold for annoyance varies greatly among individuals. Based on the experiences of the Naval Surface Warfare Center (Dalhgren, VA), USACHPPM uses the set of guidelines in Table 2-4 to assess complaint risk. Two separate PK15(met) noise contours where modeled for current (baseline) operations. The first (Figure 4-4) consists of all baseline activity with the exclusion of the relatively infrequent large demolition (NEW - 40lbs or greater) charges. These activities occur at Range 17A less than ten times per year and are not representative of a “typical” day on Fort McCoy. The second (Figure 4-5) includes all demolition activity, which adds the 40lb or greater charges to the total.

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The risk of complaints from a "typical" days training on Fort McCoy (Figure 4-4) is considered moderate. The 130 dB noise contour extends beyond the installation boundary in two separate areas, but does not contain any sensitive receptors. The 115 dB noise contour extends well beyond the boundary to the west, as well as to the north and east. However, with the rural nature of the land surrounding Fort McCoy there are few sensitive receptors experiencing noise in the 115 dB to 130 dB moderate risk category.

The risk of complaints when large demolitions are added (Figure 4-5) is also considered moderate. As expected, the 115 dB contour extends further west-northwest from Range 17A and contains several sensitive receptors; however, the 130 dB noise contour remains relatively localized to the installation and contains no sensitive receptors.

4.2.4 AIRCRAFT NOISE

Fort McCoy operates a joint use airfield with the City of Sparta. The Army leases a portion of the airfield/airport to the city and subsequently allows civilian aircraft to utilize the airfield; however, there is no scheduled civilian air service available. The City of Sparta's exclusive use area encompasses 19 acres on the southwest side of the airport. The airport has two runways:

- Runway 19-01, overall length 4295 feet x width 100 feet.
- Runway 29-11, overall length 4708 feet x width 100 feet.

There are three flight tracks to and from the runways:

- GPS 11 Flight Track
- GPS 29 Flight Track
- NDB 29 Flight Track

And three closed pattern tracks around the airport:

- Closed Track 01-19
- Closed Track 11-29
- Closed Track Young Assault Strip

The flight tracks are shown in Figure 4-6. The majority of flights to and from the airport are military, accounting for nearly twice that of civilian operations. The airport had a total of 8,854 operations (5,312 Military / 3,508 Civilian) in CY 2006 , however, a large portion of these flights do not use the airport runways; rather they are considered Flight Follows (FF) which pass through the Sparta-McCoy airspace at varying altitudes. Actual operations utilizing the runways (take-offs and arrivals) at Sparta-McCoy are significantly lower (2,110 Military / 1,155 Civilian). Table 4-5 gives the breakdown of operations *without* Flight Following statistics.

These numbers are low enough that they would not generate a 65 A-weighted DNL (ADNL) noise contour that would leave the installation boundary.

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Type	Operations	Aircraft
Military Rotary-Wing	1,131	UH-1, UH-60, OH-58, CH-47, and CH-53
Military Small Fixed-Wing	688	C-12 and UC-35
Military Large Fixed-Wing	291	C-130 (80%) and C-17 (20%)
Military Total	**2,110**	
Civilian Rotary-Wing	84	Bell and Eurocopter
Civilian Fixed-Wing	1,071	Small/Light up to Citation
Civilian Total	**1,155**	

Table 4-5 Aircraft Operations at Sparta-McCoy Airport (CY 2006)

This is not to say that aircraft operations do not have the potential to cause annoyance or complaints. As briefly touched on in chapter two, ADNL is an average, which may not be the best predictor in terms of complaint potential. Scandinavian Studies (Rylander 1974 and Rylander 1988) have 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. These maximum levels can than be compared to the percentages of those individuals who would consider themselves highly annoyed (Table 2-8). While annoyance levels may be lower at airfields with fewer than 50 operations per day, it remains an effective tool in providing some indication for complaint risk.

The tables below give the maximum levels (dBA) for the military and civilian aircraft which most commonly utilize the Sparta-McCoy Airport, the training areas (Young Air Assault Strip, RRAS, Badger DZ, Warrens DZ, Cranberry DZ and flight corridor) and airspace (mixed traffic transition areas, mixed patterns, Instrument Approach Course and Restricted Areas R6901A and R6901B) in and around Fort McCoy. Civilian levels are included for general purpose, although complaint potential is most likely far greater with military aircraft. This is simply due to the type of activity (repetitive, low-level) that military aircraft tend to practice on Fort McCoy, while civilian aircraft activity is generally transient in nature. Military aircraft also tend to be a bit noisier (particularly rotary-wing aircraft) than their civilian counterparts.

Slant Distance	Maximum Level, dBA				
(Feet)	CH-47	CH-53	OH-58	UH-1	UH-60
50	104	112	99	103	100
100	98	105	93	97	94
200	92	99	87	91	88
500	84	91	79	83	80
1,000	77	84	72	76	73
1,500	74	80	68	73	69
2,000	71	77	65	70	66
2,500	68	75	62	68	63

Table 4-6 Maximum Levels for Military Rotary-Wing Aircraft

Slant Distance (Feet)	Maximum Level, dBA Bell 206	Eurocopter 350
100	91	88
200	85	82
500	76	74
1,000	70	67
1,500	65	63
2,000	63	60
2,500	60	58

Table 4-7 Maximum Levels for Civilian Rotary-Wing Aircraft

Slant Distance (Feet)	Maximum Level, dBA C-12	C-130	C-17	UC-35
100	94	106	115	112
200	88	100	108	106
500	79	92	98	97
1,000	73	85	90	89
2,000	67	77	80	82
3,000	63	73	74	77
4,000	60	69	70	73
5,000	57	66	66	70

Figure 4-8 Maximum Levels for Military Fixed-Wing Aircraft

Slant Distance (Feet)	Maximum Level, dBA Single Engine (Variable Pitch)	Twin Turbo Prop	Light Jet Citation V
100	98	94	112
200	92	88	106
500	84	79	97
1,000	78	73	89
2,000	71	67	82
3,000	67	63	77
4,000	63	60	73
5,000	61	57	70

Figure 4-9 Maximum Levels for Civilian Fixed-Wing Aircraft

The majority of military operations on Fort McCoy consist of rotary-wing aircraft utilizing the flight tracks to and from the Airport, as well as the "military" flight corridor seen in Figure 4-7. These aircraft usually fly at varying altitudes, and in the case of the military flight corridor (which essentially tracks the installation boundary) can go as low as tree top level.

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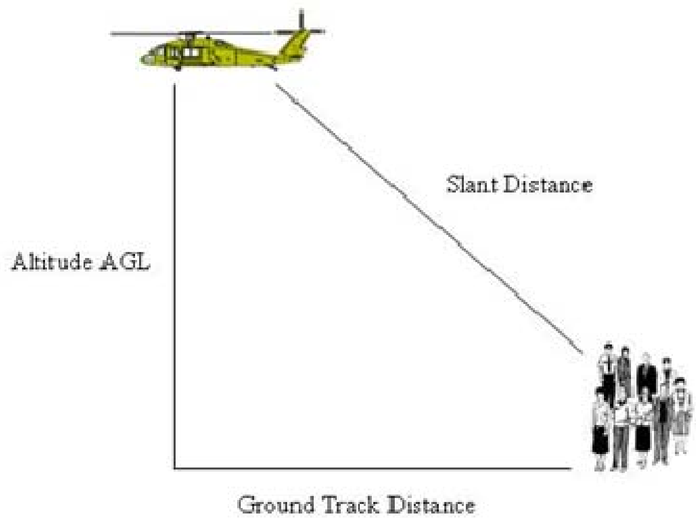
Flight corridors/tracks vary in width depending upon the type of aircraft and type of activity. Generally, the aircraft fly the center line of the flight corridor, but at times may fly anywhere within the corridor. Thus, to account for possible annoyance, the area of noise impact must be expanded based on the actual aircraft location within the corridor. For example, if a flight corridor is 100 meters in width for a UH-60 at 500 feet AGL, to account for variation in aircraft location, a buffer should be delineated that would account for activity anywhere within the corridor, not just the center line. The SelCalc Program (U.S. Air Force 2005) was used to calculate how far from the outer edges of the flight corridor maximum A-weighted noise level would be above 70 dBA (threshold for annoyance), based on the altitude, ground track distance, and slant distance of the rotary-wing aircraft listed in Table 4-6.

This provides a simple guide to what an adequate buffer for these aircraft would be from the center of the corridor/track. Table 4-10 shows the buffer widths at various altitudes. Figure 4-8 illustrates the difference between 'ground track distance' and 'slant distance'.

	Buffer Widths to Flight Corridor					
Aircraft Type	**< 100' AGL**	**500' AGL**	**1000' AGL**	**1500' AGL**	**2000' AGL**	**2500' AGL**
Military Rotary Wing:						
CH-47	1/3 Mile	1/3 Mile	1/3 Mile	¼ Mile	¼ Mile	1/8 Mile
CH-53	3/8 Mile	3/8 Mile	5/8 Mile	5/8 Mile	5/8 Mile	½ Mile
OH-58	¼ Mile	¼ Mile	1/8 Mile	1/8 Mile	n/a	n/a
UH-1	¼ Mile	1/3 Mile	1/3 Mile	¼ Mile	1/8 Mile	n/a
UH-60	¼ Mile	¼ Mile	¼ Mile	1/8 Mile	1/8 Mile	n/a

Table 4-10 Fort McCoy Military Flight Corridor Buffer Widths



Ground Track Distance: The distance between receiver and the point on the Earth at which the aircraft is directly overhead.

Slant Distance: The line-of-sight distance between the receiver and the aircraft. The slant distance is the hypotenuse of the triangle represented by the altitude of the aircraft and the distance between the receiver and the aircraft's ground track distance.

Figure 4-8 Ground Track/ Slant Distance Definition

Taking the loudest rotary wing-aircraft into account (CH-53), these buffers were produced for the closed pattern flight tracks (Figure 4-9) and the GPS 11 flight track (Figure 4-10) due to their proximity to the town of Sparta and possible residential overflight. Rotary-wing aircraft flying within the closed track must maintain 1600' AGL, thus this buffer represents 5/8 of a mile. Figure 4-10 shows the approximate distance and height for the CH-53 aircraft departing and arriving on the west end of the 29-11 runway. Although the buffer width would vary at different AGL for this track, a width of 5/8 of a mile was used for this track for simplicity, and to represent a worst case scenario. Figure 4-11 illustrates the Fort McCoy military flight corridor also with a buffer applied. Again, this buffer represents the CH-53 aircraft at 1000' AGL, thus the buffer is 5/8 of a mile.

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4.3 FUTURE NOISE ENVIRONMENT

The following discussion deals with future or forecast conditions for noise occurring on and around Fort McCoy. These forecast conditions are based on estimates for future training and range usage on Fort McCoy. The Federal guidelines pertaining to compatible and incompatible land use are used, so that future land use can be evaluated as to acceptability for various types of activities.

4.3.1 SMALL ARMS NOISE

Fort McCoy has proposed the construction of a new Qualification Training Range (QTR) facility on south post for rifle and pistol live fire, which will be on the existing Range 100 footprint. A QTR facility of this type is used to train and test soldiers on the skills necessary to detect, identify, engage and defeat stationary and moving infantry targets. The primary features of a standard QTR facility generally include:

- 15 Lanes Combat Pistol Qualification
- 10 Lanes Sniper Fire
- 16 Lanes Modified Record Fire
- 10 Lanes Multi-purpose Machine Gun
- 32 Lanes rifle/ Machine Gun Zero

The current Range 105 will also receive updates and be used as a 25 meter Zero Range. The combined existing (Range 101 and 102) and forecast (Range 100 and 105) noise contours for small arms on south post are shown in Figure 4-12. The Zone III noise contour extends just beyond the Fort McCoy boundary in a small area north of Range 102. The Zone II noise contour extends beyond the installation boundary to the east, west and north and appears to contain several private residences. Although the contours do meet with Federal guidelines, those individuals living within the Zone II might find the firing at the QTR facility particularly intrusive at the outset. This would be due in part to the transition of extended periods of inactivity from the current small arms ranges to an active live-fire range. This of course would be dependent upon the frequency of firing on the QTR when it becomes operational, however, extra steps should be taken to notify the surrounding citizens before any live fire activities resume as well as before periods of frequent use (summer months etc.).

Fort McCoy has also proposed the construction of a Combined Arms Collective Training Facility (CACTF) in Training Areas B-25, B-26 and portions of B-27. This training facility would be designed to conduct multi-echelon, full spectrum operations training (offense, defense, stability, and support operations) up to the battalion task force level, accommodating Force-on-Force and Force-on-Targetry training. Training operations would include heavy and light infantry, armor, artillery, and aviation positioning and maneuver. The CACTF would support the following ammunitions:

- Blank ammunition training;
- Multiple Integrated Laser Engagement System (MILES)
- Special-Effects, Small-Arms Marking System (SESAMS) - (Paint Rounds)

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The CACTF is meant to mimic an urban environment and/or replicate an urban battlefield. From a noise stand point this facility is not unlike the current MOUT facilities discussed in Section 4.2.1. Due to the type of firing and the interior position of the facility, noise generated from the CACTF would be considered negligible.

4.3.2 LARGE CALIBER WEAPONS AND DEMOLITION NOISE

Although there are no new range facilities proposed in the forecast scenario for large caliber weapons, there are several activities scheduled to return to Fort McCoy, as well as an increase in units training and utilizing firing points which currently receive little use. Appendix B (B.2.1) lists the operations that were used to model the forecast noise contours, which includes all of the baseline operations. The majority of additional operations include the heavy use of artillery (155mm and 105 mm Howitzer/ Paladin) and mortar weapons, as well as the Multiple Launch Rocket System (MLRS). The operations data was provided by the Range Control Office and based on historical Operation Iraqi Freedom pre-deployment data. These units (WIARNG, IAARNG, ILARNG and others) and activities will undoubtedly return to training on Fort McCoy in a post Operation Iraqi Freedom scenario.

The CDNL noise contours for forecast operations on Fort McCoy are shown in Figure 4-13. The Zone III noise contour extends beyond the installation boundary in several locations, but does not contain any incompatible land uses. The Zone II noise contour extends beyond the boundary to the east, north, and most notably to the west. The “normally incompatible” Zone II does contain sensitive land uses off-post as well as several structures on-post in the cantonment area. The LUPZ continues past the Zone II to envelope areas east, west and north of Fort McCoy.

As is was with the current noise section, to provide a better representation of the future noise complaint risk, two separate PK15(met) noise contours where modeled for future (forecast) operations. The first (Figure 4-14) consists of all forecast activity with the exclusion of the relatively infrequent large demolition charges (same as baseline). Thus, Figure 4-14 is meant to represent a “typical” day on Fort McCoy in the forecast scenario. The second PK15(met) noise contours (Figure 4-15) include all activity, which adds the 40lb or greater charges, including several charges in the 150lb to 200lb range to the total. It should be noted that future artillery fire (Paladin) can take place anywhere north of Highway 21 (excluding the Cantonment area and Campground), which is reflected in both PK15(met) noise contours.

The risk of complaints from the forecast typical training scenario (Figure 4-14) is considered moderate to high. The 130 dB noise contour extends beyond the installation boundary on the entire northern portion of the installation. Several areas appear to contain sensitive receptors close to the installation boundary. The 115 dB noise contour extends beyond the boundary in all directions as well, covering what are primarily agricultural uses; however, there are several private residences within the 115 dB contour.

The risk of complaints when demolitions activity is added is considered high. The 130 dB contour is larger most notably to the west-northwest, and reaches nearly as far north as Highway 12. The 115 dB noise contour is also significantly larger, extending much further north and west (past Highway 27), as well as east, past Interstate 94 to the town of Warrens.

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4.3.3 AIRCRAFT NOISE

Although current operations at the Sparta-McCoy Airport are low enough that they do not generate a DNL noise contour off the installation boundary, determining a threshold for future operations tempo is a worthwhile exercise. Using the SelCalc Program (U.S. Air Force 2005) as well as the current aircraft utilizing the airport (2006), it would take approximately twice the amount of operations per year (6,530) to generate a 65 ADNL noise contour which would reach the installation boundary. This analysis uses only the GPS 11 flight track and assumes all activity departing and arriving on Runway 11. This also takes into account an equal percentage of usage such as seen in Table 4-5. For instance, military aircraft account for roughly 34 % of the total operations in Table 4-5, thus an equal usage was used to derive a threshold scenario. Changing the type and amount of aircraft obviously changes the amount of operations needed. This makes this type of analysis largely academic; however, it does provide some insight into possible future operations and their perceived impact.

4.4 SUMMARY AND RECOMMENDATIONS

The primary source of operational noise on Fort McCoy is generated through large caliber weapons firing and explosive detonation activities. According to Federal guidelines, there are few incompatible land uses within the annual average C-weighted (DNL) Noise Zones II and III for large caliber weapon and detonation activities current or future. This is primarily due to the rural nature of the Fort McCoy area, where the majority of land use is agricultural and residential land use is low density. However, a moderate to high risk of noise complaints does exist through predicted peak noise levels for these same operations, particularly demolition operations in excess of forty pounds.

The only recommendation at this time is for the PAO to alert the public (press release etc.), each instance, when current demolitions operations are equal to or greater than forty pounds at any range. This will help to reduce the potential for noise complaints from these activities. This will require communication with and cooperation from the Range Control Office operators. Any and all noise complaints should continue to be addressed immediately and logged for future reference.

5.0
LAND USE POLICY AND CONTROL

5.1 GENERAL

The key to the mutually beneficial coexistence of military installations and communities is sensible land use planning around the installation. In the end, the installation can do everything possible within its mission to limit noise, but if the planning around the installation is not prudent, incompatible uses will find their way to the installation's boundary and the installation's existence (and possibly the economic backbone of the community) could become jeopardized.

Sensible, proactive land use planning (i.e., **before** there is a problem) can create a win-win situation for all parties.

5.2 FEDERAL LAND USE CONTROL

The only direct land use controls available to the federal government result from fee-owned land and easements related to federal projects. Federal agencies such as the U.S. Natural Resources Conservation Service, U.S. Forest Service, U.S. Agricultural Stabilization and Conservation Service, and U.S. Geological Survey provide assistance to landowners to manage their land and water resources to maintain agricultural and aesthetic quality.

5.3 LAND USE PLANNING AND THE ARMY

A great part of the success of the United States of America can be attributed to its strong laws protecting personal property rights. The United States military is a constitutionally charged protector of those rights and has no interest in dictating what an owner may or may not do with his/her property, what a community should put in any particular place, or what value any given parcel of land should have. With that said, an installation would be remiss if it did not point out the benefits it brings to a community and how those benefits may be imperiled by the decisions (or lack thereof) of local community planners.

Communities all over the country have employed various means to protect entities that they deem to be valuable. This protection has ranged from implementing building codes to ensure that new construction in popular historic areas maintains the existing architectural heritage, to guarding the small-town feel of a Main Street by restricting the size of businesses that may enter a "downtown" business district. What all of these initiatives have in common is that they are intended to steer new development in a direction that is most appropriate given a need to preserve the value to the community of what has already come before. Sensible initiatives to ensure compatible land use around military installations are no different.

5.4 STATE OF WISCONSIN LAND USE CONTROL

Under the provisions of Chapter 16.023 of the Wisconsin Statutes, the legislature has encouraged state-wide land use planning through the establishment of the Wisconsin land council. The functions of the land council are listed below:

The Wisconsin land council shall conduct the following functions:

(a) Identify state land use goals and recommend these goals to the governor.

(b) Identify state land use priorities to further the state's land use goals and recommend to the governor legislation to implement these priorities.

(c) Study areas of cooperation and coordination in the state's land use statutes and recommend to the governor legislation to harmonize these statutes to further the state's land use goals.

(d) Study areas of the state's land use statutes that conflict with each other and recommend to the governor legislation to resolve these conflicts to further the state's land use goals.

(e) Identify areas of the state's land use statutes that conflict with county or municipal land use ordinances, and areas of county or municipal land use ordinances that conflict with each other, and recommend to the governor legislation to resolve these conflicts.

(f) Establish a technical working group that is composed of the state cartographer, a representative of the University of Wisconsin System who has expertise in land use issues and any other land use experts designated by the council's chairperson, to study the development of a computer-based Wisconsin land information system and recommend to the governor legislation to implement such a computer system.

(g) Establish a state agency resource working group that is composed of representatives of the departments of administration, agriculture, trade and consumer protection, commerce, natural resources, revenue, transportation and other appropriate agencies to discuss, analyze and address land use issues and related policy issues, including the following:

1. Gathering information about the land use plans of state agencies.
2. Establishing procedures for the distribution of the information gathered under subd 1 to other state agencies, local units of government and private persons.
3. The creation of a system to facilitate, and to provide training and technical assistance for the development of, local intergovernmental land use planning.

(h) Study the activities of local units of government in the land use area to determine how these activities impact on state land use goals, and recommend to the governor legislation that fosters coordination between local land use activities and state land use goals.

(i) Identify procedures for facilitating local land use planning efforts, including training and technical assistance for local units of government, and recommend to the governor legislation to implement such procedures.

(j) Gather and analyze information about the land use activities in this state of the federal government and American Indian governments and inform the governor of the impact of these activities on state land use goals.

(k) Study any other issues that are reasonably related to the state's land use goals, including methods for alternative dispute resolution for disputes involving land use issues, and recommend to the governor legislation in the areas studied by the council that would further the state's land use goals.

(l) Gather information about land use issues, at its discretion, in any reasonable way, including the following:

1. Establishing a state-local government-private sector working group to study and advise the council on land use issues.
2. Holding public hearings or information meetings on land use issues.
3. Conducting surveys on land use issues.
4. Consulting with any person who is interested in land use issues.

(m) Enter into a memorandum of understanding with the land information board to ensure cooperation between the council and the board and to avoid duplication of activities.

The legislature has also enabled every level of local government to engage in land use planning. Of particular relevance to the unincorporated area around Fort McCoy is Chapter 59, Counties, Subchapter VII, Land Use, Information and Regulations, Environmental Protection Surveys, Planning and Zoning. In Chapter 59.69 (3), the legislature authorized County Development Plans. The extent of a county's power has been defined in 59.69 (4) where the legislature states the purpose to be the promotion of "public health, safety and general welfare." In 59.69(4)(b), the legislature includes "areas in which residential uses may be regulated or prohibited" (IENMP 2003).

5.5 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 have detailed the existing and imminent encroachment threats, and given focused recommendations for how to remedy them. But, what do installations and communities do to tackle problems in the future?

In general, USACHPPM uses the Federal Interagency Committee on Urban Noise (FICUN, 1980) guidelines (shown in Appendix E) when recommending land use options for areas near noise producing activities. While these guidelines only apply to noise measured in the A-weighted DNL (not blast noise), they apply to the noise produced by many of the most common sources such as transportation and maintenance/testing operations.

5.6 LOCAL LAND USE CONTROL

Wisconsin has eight Regional Planning Commissions (RPCs) and 14 metropolitan planning organizations (MPOs). All but six counties in the state (Columbia, Dane, Dodge, Jefferson, Rock, and Sauk) are served by an RPC. Figure 5-1 illustrates the RPCs and MPOs.

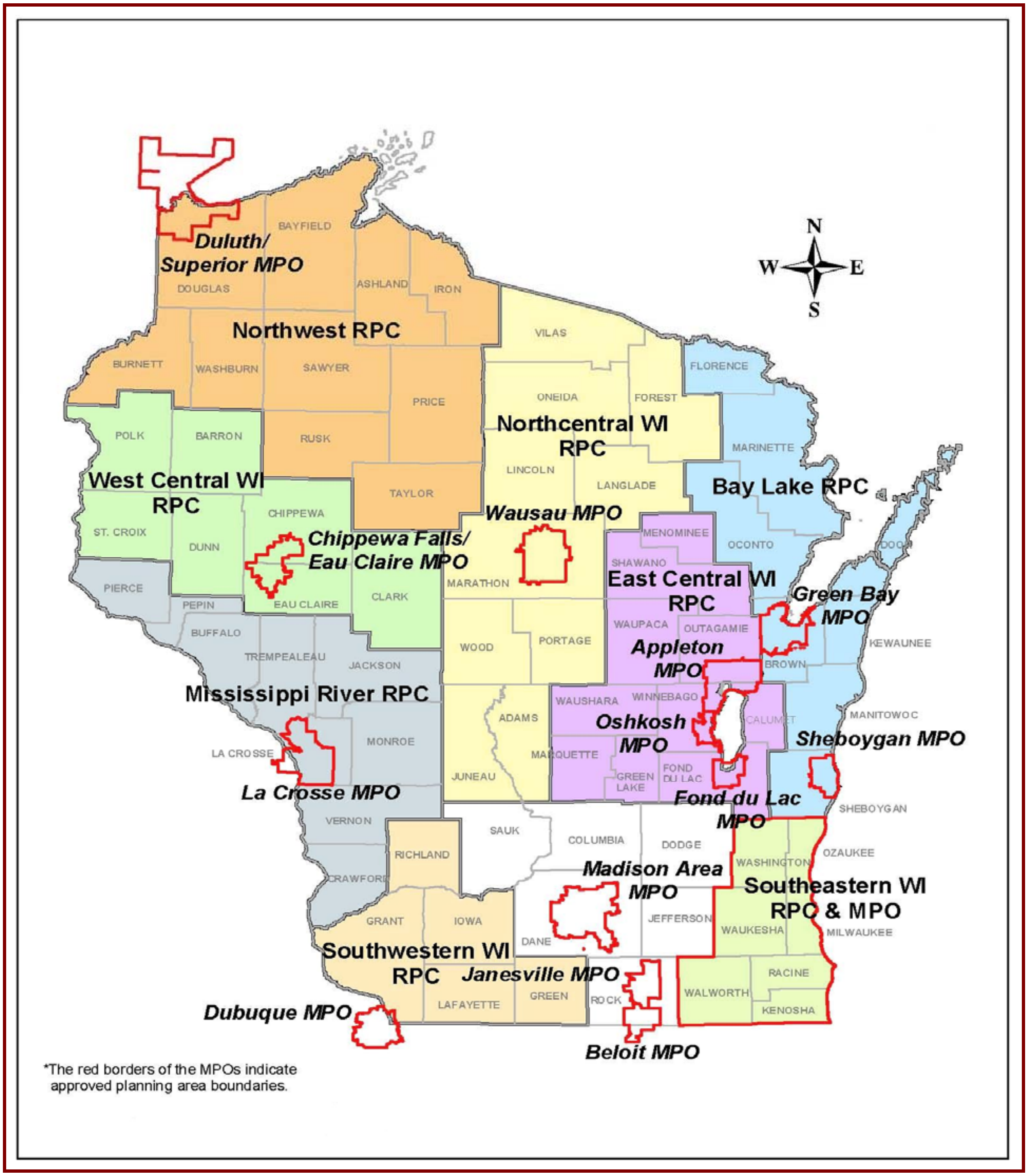

Figure 5-1 Wisconsin RPC and MPO Locations

5.6.1 MONROE COUNTY

Monroe County is a member of the Mississippi River Regional Planning Commission (MRRPC). The MRRPC is a Commission of nine counties (Buffalo, Crawford, Jackson, LaCrosse, Monroe, Pepin, Pierce, Tremealeau, and Vernon) located along the Mississippi River in Western Wisconsin. The Commission was organized in 1964 to provide planning assistance on regional issues, assist local interests in responding to state and federal programs, provide advisory service on regional planning problems, act as a coordinating agency for programs and activities, and provide cost shared planning and development assistance to local government.

Specific examples of services include: comprehensive community plans, zoning and subdivision ordinances, grant writing, geographic information system map production, revolving loan fund administration, economic development planning, economic data collection and dissemination and public advocacy on issues affecting the region. Commission activities are directed by a Board of 27 Commissioners appointed by the County Boards and Governor. Each County is represented by three commissioners.

Monroe County does not restrict residential development based on noise. Nor is there a provision for regulating residential construction to reduce noise impact. Monroe County gathers its land use regulatory authority under the Wisconsin Statutes 59.01(51), 59.97, 59.971, 59.99, 87.30, 144.26, 236.45 and Chapter 68.

5.6.2 CITY OF SPARTA

The City of Sparta Comprehensive Plan designates new residential growth away from Fort McCoy. The City of Sparta in conjunction with the Town of Sparta completed a Smart Growth Comprehensive Plan in 2003. The plan addresses future growth and designates specific areas for the growth to occur. The plan guides future residential growth to the north, south and west of the city, away from Fort McCoy.

Industrial and commercial growth is designated to the south and east of the city, in the general direction of Fort McCoy. The area designated for industrial and commercial growth adjoins the installation near the location of the Sparta/Fort McCoy Airport. The remainder of property adjacent to the installation is designated for Agriculture/Estate Residential (large parcel low density residential). There is not adequate land area adjacent to the commercial/ industrial properties for large scale residential developments adjacent to Fort McCoy. The potential low population density of the remaining areas designated Agriculture/Estate Residential should not pose an immediate encroachment threat to Fort McCoy due to the density limitations of the land use districts (MRRPC 2007).

5.6.3 CITY OF TOMAH

Similar to Sparta, the City of Tomah completed a City of Tomah Comprehensive Plan in 2002. Historically, residential growth in and around Tomah has taken place to the northwest of the city. This is in the general direction of Fort McCoy. Residential growth has occurred in this direction primarily because natural environmental constraints (wetlands, topography, etc.) have precluded development from advancing in other directions. The comprehensive plan does recognize the current development patterns and strongly emphasizes the need to infill development within existing municipal corporate limits. The plan also identifies action items (objectives) to accomplish this goal (MRRPC 2007)

5.7 THE JOINT LAND USE STUDY (JLUS)

The JLUS is a collaborative land use planning effort involving the military installation and adjacent local governments that evaluates the planning rationale necessary to support and encourage compatible development of land surrounding the installation. Put another way, it is a means for the installation and local governments to develop a land use 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.

Specifically, the JLUS program is sponsored by the Department of Defense Office of Economic Adjustment (OEA) (DODI, 1983), and it provides technical and financial assistance to the planning agencies for developing master 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 split between the OEA and the jurisdictions 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 (particularly noise); transportation improvements, existing and proposed routes; and noise/vibration.

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 proposals 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 the communities therein.

While the study report makes certain recommendations, it must be kept in mind that 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.

Many states including North Carolina (Fort Bragg, Pope AFB, MCAS Cherry Point), Pennsylvania (NAS/NRB Willow Grove), and South Carolina (MCAS Beaufort) have had success utilizing the JLUS program to direct their land use strategies. On top of this, for fiscal year 2005, the Army had eight more JLUS' funded and underway in Massachusetts, Mississippi, Arizona, Georgia, California, Kansas, and Pennsylvania (awaiting outcomes).

5.8 LAND USE PLANNING OPTIONS

The following is a list of the major land use planning tools available to help local governments create areas of compatible use around military installations. These may be used individually or in combination, and a detailed explanation of the pros and cons of each is available in Appendix D.

1. Zoning
2. Overlay Districts
3. Easements
4. Transfer of Development Rights (TDR)
5. Land Purchase
6. Building Codes
7. Subdivision Regulation
8. Health Codes
9. Disclosure of Noise Levels
10. Land Banking
11. Special Tax Treatment
12. Capital Improvements Program (CIP)
13. Development Loan Restrictions
14. Public/Private Leaseback
15. Sales Agreement
16. Deed/Covenants
17. Purchase of Development Rights
18. Eminent Domain
19. Purchase Option

While this is a substantial portion of the options available, installations and local governments are strongly encouraged to be creative to find the equitable solutions that best work for their situation.

5.9 ENVIRONMENTAL JUSTICE

Environmental Justice (EJ) is an important consideration in any land use plan. It is defined by the U.S. Enviromental Protection Agency as the "fair treatment of people of all races, cultures, and incomes, regarding the development of environmental laws, regulations, and policies."

Over the last decade, there has been growing attention focused on the impact of environmental pollution on particular segments of our society. The concern that some populations bear a disproportionate amount of adverse health and environmental effects led President Clinton in 1994 to issue Executive Order 12898 focusing federal agency attention on these issues. To this end, installations and local governments should ensure that the EJ philosophy is embraced when any new measures are enacted to ensure compatible development around military installations. Decisions should be based strictly on the operational, safety, and environmental considerations of both the installation and the community, not on whether a particular group is more or less likely to complain.

5.10 CONCLUSION

The evenhanded resolution of any situation involving a disparate population of stakeholders requires flexibility, creativity, direction, good-will, and the most accurate information available. Effective land use planning is no different.

And, while the entire labyrinth of local regulations cannot be explained in this document, it is imperative that installation commanders and decision-makers become familiar with the local land use regulations and development climate around their installations in order to properly gauge the possibility of impending encroachment issues. Maintaining a familiarization with local regulations by visiting local government offices; a knowledge of federal/installation-initiated tools and programs (such as the JLUS); and a consciously cultivated relationship with local government officials are the best ways to address issues of encroachment before they in fact become issues.

This Operational Noise Management Plan provides the information and the direction, but it is up to the installations and communities to provide the other elements to ensure a mutually beneficial coexistence.

Appendix A

Description of Noise, Noise Evaluation, and Contouring

A.1 INTRODUCTION

Military noise comes from a variety of sources and is a concern for a number of reasons. Of course big guns make big sounds, but the noise made by everything from generators to trucks to machine shop tools must be considered as well. For the military, issues involving noise can be broken down into two components: hearing conservation as it pertains to the physical damage to the ear caused by sound, and operational noise as it relates to complaints and encroachment.

The first involves the exposure to noise by individuals who are performing their duties. Since loud sounds are known to cause immediate and/or cumulative hearing damage, the military must be constantly monitoring the noise exposure of its employees and soldiers, both in day-to-day and combat situations.

The second (and the focus of this piece) centers upon the problems caused when military sounds irritate the pubic—whether through poor decisions by installation personnel, or through or increasing encroachment around a once-remote installation.

In order to understand how military sounds become a problem, it is important to understand the science of sound, and what happens when a sound becomes a noise.

A.2 WHAT IS NOISE?

Noise is simply unwanted sound. So, in the context of hard science, there is no difference between the two. However, whether something is a “sound” or a “noise” has a great influence over the military’s everyday planning and policy decisions as it tries to fulfill its Constitutionally-charged duty to protect the citizens of the United States of America.

In short, sound isn’t noise until someone says it is; and when it is, it needs attention.

A.3 THE FUNDAMENTALS OF SOUND AND ACOUSTICS

Sound is a physical phenomenon created by minute variations about a mean pressure (or *vibrations*) that travel through a medium such as air or water. This variation in pressure takes the form of waves and, under ideal conditions, these waves travel evenly away from the source much like the ripples created when a pebble is dropped into calm water.

However, life on earth is rarely so perfect and the travel of these waves is always being influenced by variables such as temperature, terrain, and barriers. Add to those physical influences the fact that our human experience of audible sounds depends on the pattern of vibrations form the source, the way our hearing mechanism interprets these vibrations, and how our personalities affect how we feel about those vibrations, and one can begin to grasp the complexity of issues involving sound and noise.

The field of science that deals with all of these variables as well as the production, control, reception, effects, and propagation is called *acoustics*.

A.3.1 THE CHARACTERISTICS OF SOUND

As an object moves back and forth in the atmosphere, it collides with the surrounding air particles creating a pressure disturbance. As those air particles collide with adjacent air particles, the pressure disturbance begins to spread away from the source of vibration. At the ear, this disturbance generates a vibration in the eardrum that is transmitted via a network of bones to the cochlea, which then converts the vibration into an electrical signal that the brain can interpret.

A sound is measured by gauging the alternate *compression* ("bunching") and *rarefaction* ("spreading") of the acoustic pressure disturbance above and below the normal atmospheric pressure, and is quantified in units called *Pascals* (Pa). Normal atmospheric pressure at sea level is 100,000 Pa, and sound waves generally travel at approximately 1,100 feet (335 meters) per second through air. For reference, the variation about this atmospheric pressure can be a little as 0.0006 Pa (or 60µPa) for a whisper at 2 meters, to 1,000 Pa for an M16 rifle shot at the firer's ear.

As with all waves, the energy and effects of a sound are dependent upon the sound wave's *frequency* and *wavelength*. Frequency is the number of compressions of rarefactions per unit of time. Wavelength is the distance between successive compressions or successive rarefactions (see Figure A-1).

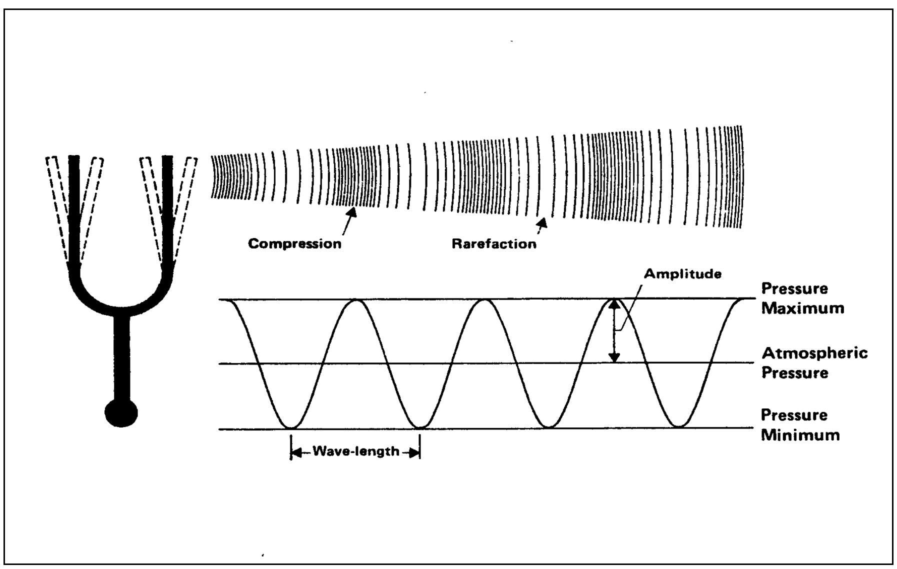

Figure A-1 Acoustics of a Pure Tone

Of course, sounds can bring us important information and/or pleasure. But, whether or not that is the case is dependent on two things: the content of the sound and the predisposition of the receiver to the sound.

When a sound brings neither pleasure nor information, it is safe to call it a noise.

A.3.1.1 SOUND CONTENT AND HUMAN HEARING

The content of a sound is determined by three defining characteristics:

(1) its spectral or frequency content;

(2) its loudness or intensity; and

(3) its time pattern

But, the importance of each of these is also dependent upon the innate response of a human ear that's primary function was to keep people alive, not critique M-16 fire.

A.3.1.1.1 SPECTRUM AND FREQUENCY

Sound frequency is measured in terms of cycles-per-second or Hertz (Hz). The normal human ear can detect sounds ranging from about 20 Hz to 20,000 Hz (for reference, the average dog's hearing range is approximately 20-45,000 Hz). However, not all sounds in this wide range are heard equally well; the human ear is most sensitive to frequencies in the 1,000 to 4,000 Hz range.

As mentioned earlier, a vibrating object produces a sound wave with a characteristic frequency (a *tone*). But, there are no pure tones in the natural soundscape. Instead, any given sound found in nature is actually comprised of a complex combination of individual frequency components produced by the many different vibrational and oscillatory modes of the sound source. The total of all of these individual frequency components is known as a sound's *spectrum*, and knowledge of a sound's spectrum is a key in any attempt to mitigate the sound.

A.3.1.1.2 LOUDNESS AND DECIBELS

The concept of *volume* (i.e., relative loudness or quiet) is fundamentally about the level of sound pressure hitting the eardrum. Historically (and for obvious reasons), the first scientists to seriously study the ear's response to sound pressure were telephone engineers. These scientists soon discovered that the human ear responds to a very broad range of pressures and subsequently invented a logarithmic scale using the *decibel* (dB) as its unit of measurement.

The scale is zeroed at the beginning of human hearing (20µPa) and, since the scale is logarithmic, each one dB increase is a 10x increase in pressure (see Figure A-2).

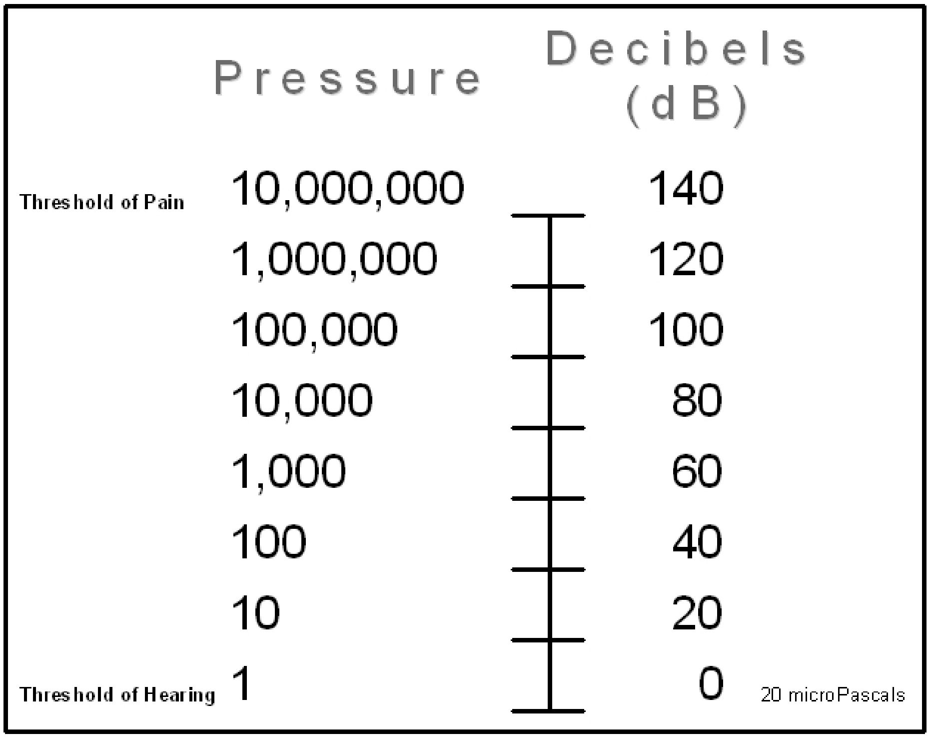

Figure A-2 Relationship between Sound Pressure and Decibels

For humans, the upper tolerable limit of loudness before hearing damage occurs depends on the frequency and duration of the sound. For example, a 20 millisecond rifle shot at a 140 dB level can damage the hearing in some unprotected ears. But a howitzer shot at 140 dB, with its lower frequency (i.e., it's not as "sharp" as the rifle shot), is far less likely to cause hearing damage. Alternately, a passing sound at 120 dB is enough to cause only discomfort, while several minutes of such exposure can cause damage. And, moving further down the scale, one could tolerate as much as 8 hours of 85 dB before damage becomes a possibility.

Though laboratory studies have demonstrated a greater acuity, for practical purposes it takes a plus-or-minus three dB change in pressure (roughly a doubling or halving of energy) for a person to notice a difference across most audible frequencies.

But, because of the logarithmic nature of the decibel, dBs do not add directly. To get an exact answer, the root pressures of the sounds to be added must be combined and then converted to decibels using the following formula:

$$\textbf{Pressure (dB)} = \textbf{10 log (}\underline{\textbf{Measured Pressure/20 microPascals}}\textbf{)}$$

Table A-1 shows the short cuts to dB addition, but these are only to be used for quick approximations.

When Two Levels Differ By:	Add the Following to the Higher Value:
0 to 1 dB	3
2 to 3 dB	2
4 to 9 dB	1
10 or more dB	0

Table A-1 Shortcuts to Decibel Addition

A.3.1.1.3 VIBRATION

Often hand-in-hand with the discussion of loudness comes the phenomena of *vibration*. Vibration in the context of military training is caused by the impact of lower frequency sound waves on unsecured objects. In fact, there are situations where vibration can be the primary irritant to the public, because the sound making the vibration is too low for the human ear to hear. Thus, a citizen may have little idea that training operations are occurring at all until a picture falls off of the wall.

Vibration issues can largely be abated by appropriate construction techniques (e.g., heavy outer walls, suitable duct design, sealing of cracks, etc.) and prescient site planning. Additionally, while many citizens are fearful that vibration may damage their homes, the threshold for damage to even a poorly constructed house is far greater than the tolerance of the occupants is likely to be.

A list of "dos" and "don'ts" is published in an Army Construction Engineering Research Laboratory (CERL) report, Expedient Methods for Rattle-Proofing Certain Housing Components, and that report (or additional information on vibration in general) can be obtained from CERL or USACHPPM.

A.3.1.1.4 TIME PATTERNS

Time patterns are extremely important to the discussion of sound because it is so important in predicting annoyance.

Sound can be classified into four basic categories that define its basic time pattern:

(1) *Ambient.* Ambient sound is the ever-present collection of background sounds at any given place. Ambient sound can be strictly natural such as frogs and cicadas in the deep woods, strictly mechanical such as street noise in a busy city, or a combination of both like that which is found in the suburbs. It is important to consider the existing ambient soundscape because what exists already has much to do with how annoying people will find a new sound. For example, the hum of a generator will be much better tolerated by those already living in an area of high mechanized ambient noise than those living in the far woods.

(2) *Steady-state*. Steady-state sound is a sound of consistent level and spectral content such as that which originates from ventilation or mechanical systems that operate more or less continuously. From a military perspective, generators and aircraft run-up sounds are the most prominent steady-state sounds and, as a rule, the longer a steady-state sound persists, the more annoyed people will be.

(3) *Transient Sound*. Transient sound has a clearly defined beginning and end, rising above the background and then fading back into it. Transient sounds are typically associated with "moving" sound sources such an aircraft overflight or a single vehicle driving by, and they usually last for only a few minutes at the most. The annoyance caused by transient sounds is dependent upon both the maximum level and the duration.

(4) Impulsive Sound. Impulsive sound is of short duration (typically less than one second) high intensity, abrupt onset, rapid decay, and often a fast-changing spectral composition. It is characteristically associated with such sources as explosions, impacts, the discharge of firearms, the passage of supersonic aircraft (sonic booms), and many industrial processes. Impulsive sound can be particularly annoying because of the "startle factor" where the receiver has no warning that exposure to a loud sound is imminent.

The temporal aspect of a sound is important when it comes to predicting annoyance. Even a sound that is barely audible can be extremely irritating if it is continuous and is occurring at an inconvenient time (such as bedtime).

A.4 NOISE EVALUATION AND METRICS

There is little disagreement about the fact that noise must be regulated to some degree in order to maintain the quality of life for the public at large. However, noise is one of those things where everyone seems to know it when they hear it, but it has been historically difficult to define in words or numbers. This has been particularly irksome to lawmakers, because any laws regulating noise must be clearly understood to both producers and receivers in order to be effective. Consequently, over the past 30 years a wide variety of acoustic measures and rating scales have been developed for the purpose of quantifying the sound generated by particular sources.

To date there is no perfect way to quantify noise for every circumstance and condition, but there are ways to assign meaningful numbers to sounds so that they can be compared from situation to situation.

A.4.1 WEIGHTING

As stated above, due to the natural response of the human ear, the perception of loudness is not consistent across frequencies. For instance, at any sound pressure less than 90 dB, a 1000 Hz tone would sound louder than a 100 Hz tone. While this is a bit of an oversimplification, essentially, as the frequency drops, it takes more pressure (volume) to maintain the same sense of "loudness."

Accordingly, weighting scales have been developed so that the intensity of a sound (or noise) can be equalized and brought in line with the actual human perception. The weighting scales that concern operational noise are the A-scale (A-weighting) and the C-scale (C-weighting), both specified by an American National Standards Institute standard (ANSI, 1983). Figure A-3 shows the relationship between the two scales.

A-weighting

The *A-weighting* of decibels (dBA) was designed to work primarily with higher frequency sounds. In military noise, this would encompass such sounds as those from generators, aircraft, maneuver drills, and general transportation.

C-weighting

The *C-weighting* of decibels (dBC) is used for intense signals containing low frequency sound energy like those that emanate from large gun blasts, sonic booms, and detonations.

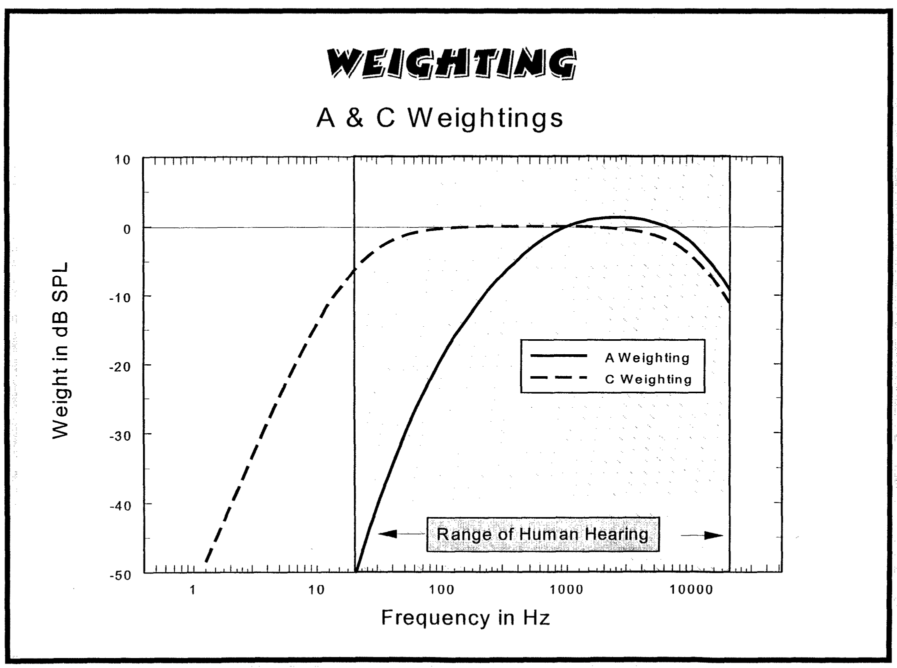

Figure A-3 A- and C- Weighting Scales

A.4.2 NOISE METRICS

The weighting scales are only one part of noise evaluation. In order to get a proper idea of the overall effect of noise, one must combine the weighting scales with the effects of a sound's time pattern to get a meaningful, all-encompassing cumulative noise measurement that can be used to compare noise exposure across a variety of situations.

Here, too, there are several choices of metrics depending on the noise environment to be measured and exactly for what the data is to be used. Many countries have their own standard metrics, but the U.S. military is concerned primarily with the following:

- Equivalent Sound Level (L_{eq})
- Day-Night Level (DNL)
- Sound Exposure Level (SEL)
- PK15(met)
- Unweighted Peak

A.4.2.1 EQUIVALENT SOUND LEVEL (L_{eq})

Since annoyance increases with the number of times an intrusive sound is experienced during a given period of time, the L_{eq} is a way of capturing the annoyance of a number of intrusions by "averaging" acoustical energy over a prescribed time period. The time period can be any length, but it is usually taken in some meaningful block of time such as an 8-hour L_{eq} for an office or a 24-hour L_{eq} for a residence. Figure A-4 illustrates how the daily variation of traffic noise can be summarized in terms of a single 24-hour L_{eq} value.

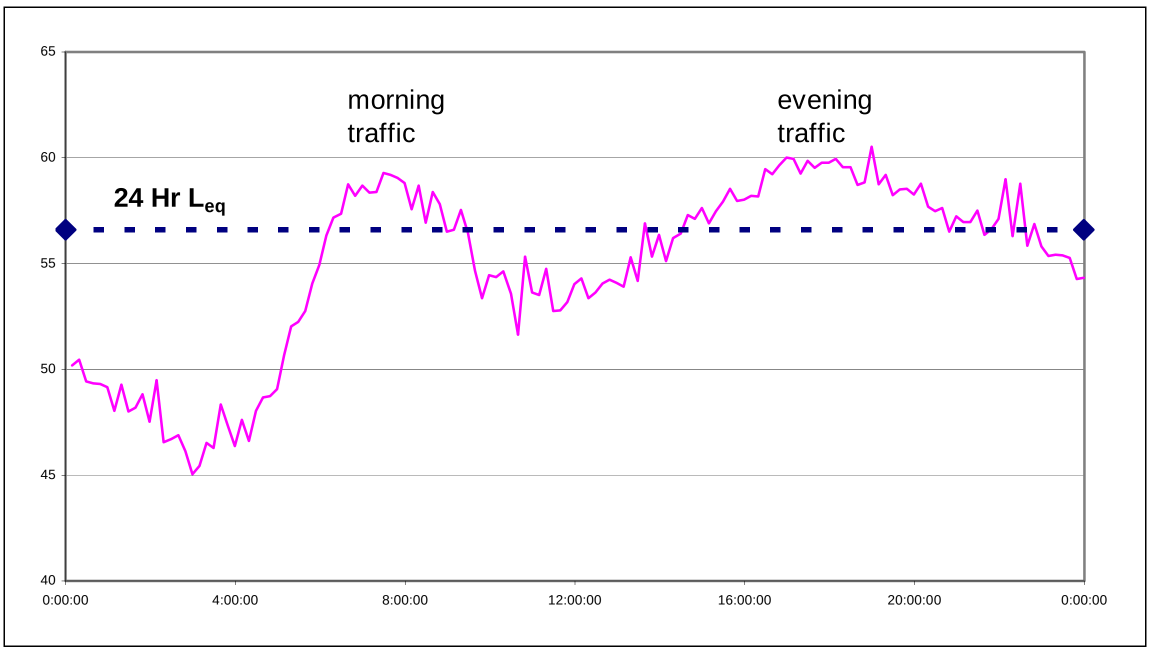

Figure A-4 Equivalent Noise Level (L_{eq})

A.4.2.2 DAY-NIGHT LEVEL (DNL)

The DNL is an average like the L_{eq} but with a 10dB "penalty" inflicted on sounds occurring between the hours of 10:00 p.m. and 7:00 a.m. (a particularly intrusive time when people are usually sleeping). As discussed above, the DNL may be A-weighted (ADNL) or C-weighted (CDNL) depending on the noise being measured. This average is calculated over any specified amount of time, but usually it is 250 training days for active military and 104 days for National Guard sites.

Also, within the DNL, there is a further penalty known as the *onset rate penalty*. For people living along aircraft flight routes, it was found that the DNL was underestimating their annoyance. So, this penalty (known as the L_{DNmr}) is used by the U.S. Air Force to take into account the sudden onset and sporadic nature of these sounds.

A.4.2.3 SOUND EXPOSURE LEVEL (SEL)

Since, prolonged, low-intensity events can be just as annoying as short, high-intensity events, the SEL is a way of capturing the annoyance of both variables in terms of a single number. It is 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. Put another way, the SEL represents all the acoustic energy of an event as if it occurred within a one second period.

A.4.2.4 PK15(met)

PK15(met) is the peak sound level, factoring in the statistical variations caused by weather, that is likely to be exceeded only 15% of the time (i.e., 85% certainty that sound will be within this range). This metric exists only in modeling—one cannot take a PK15(met) measurement on the ground—and it is used for land use planning with small arms and as additional information for large arms and other impulsive sounds. It has gained popularity for military applications in recent years because it is a metric that works very well at showing just how loud things are likely to get at a particular location. Unfortunately, PK15(met) does not take duration or incidence into consideration, so it cannot tell how often things will be that loud.

A.4.2.5 UNWEIGHTED PEAK

On of the simplest ways to measure sound is through the use of unweighted peak (dBP). This is the peak, single event sound level on the ground, without any particular certainty–such as with the 85% certainty built into the PK15(met) above. This is a real-time measurement that is affected by everything from the weather to the length of the grass. As such, it is highly variable.

A.4.3 A BRIEF HISTORY OF NOISE EVALUATION IN THE U.S. GOVERNMENT

Before the 1970's, every organization had its own preferred set of noise evaluators (or metrics). Since each noise evaluator was developed for a specific purpose, data from one noise evaluator could not be reliably compared to that of another.

However, the field moved toward standardization when, in carrying out its responsibilities under the Noise Control Act of 1972 (PL 92-574 1972), the U.S. Environmental Protection Agency recommended the adoption of the LEQ (and its 24-hour cousin, the DNL).

In recommending the DNL, the EPA noted that most noise environments are characterized by repetitive behavior from day-to-day, with some variation imposed by differences between weekday and weekend activity, and seasonal fluctuations. Consequently, the DNL's annual average accounts for this variation and complements the fact that annoyance is generally caused by long-term dissatisfaction with the noise environment. It must be kept in mind, though, that the DNL is not an effective predictor of complaints, because complaints tend to represent an individual's immediate dissatisfaction with the noise environment, not a general annoyance.

So, the acceptance of the DNL helped to predict annoyance (and general disruption patterns), but it could not fully address the issue of complaint prediction. Consistent prediction of complaints, it has been found, is much more achievable when dealing with peak noise levels rather than averages. As a result, in 2004, the U.S. Army Construction Engineering Research Laboratory (USACERL) and USACHPPM together helped to usher in the PK15(met) evaluator as a means to predict complaint potential and supplement the information given by the DNL figures.

A.5 NOISE CONTOURING

The various metrics described above produce numbers that can be compared to one another. But, it is difficult to make a number meaningful to someone interested in where the noise is going. To that end, the idea of noise contouring on maps was born.

Contours on a map are made by connecting points of equal values. Most commonly, points of equal elevation are connected to form the contour lines most typically found on topographical maps. But, points of many other themes can be detected to give a visual representation of the extent or degree of something. So, for noise, computer programs have been developed that model the genesis and propagation of sound from particular sources, and then connect points of equal decibel value to show areas where a particular sound intensity can be expected.

For instance, Figure A-5 is an example of a map showing peak noise contours. The operator of the computer model may plot whatever values she/he wishes to show, but this example shows the 130 dBP line (red) and the 115 dBP line (blue). While the lines will never be absolutely exact (due to the nature of sound, they can fluctuate quite a bit as conditions change), what this map in effect says is that all of the area inside of the blue line will start at 115 dB and grow louder as it gets closer to the red 130 dB line. And similarly, once at the red 130 dB line, the sound level will grow louder still all the way to the source.

This is eminently useful because it shows both the installations and the public not only where the sound/noise is going, but at what levels. With that, installations, local governments, and individuals can use these maps to make informed choices based on their temperaments, tolerances, and philosophies concerning noise.

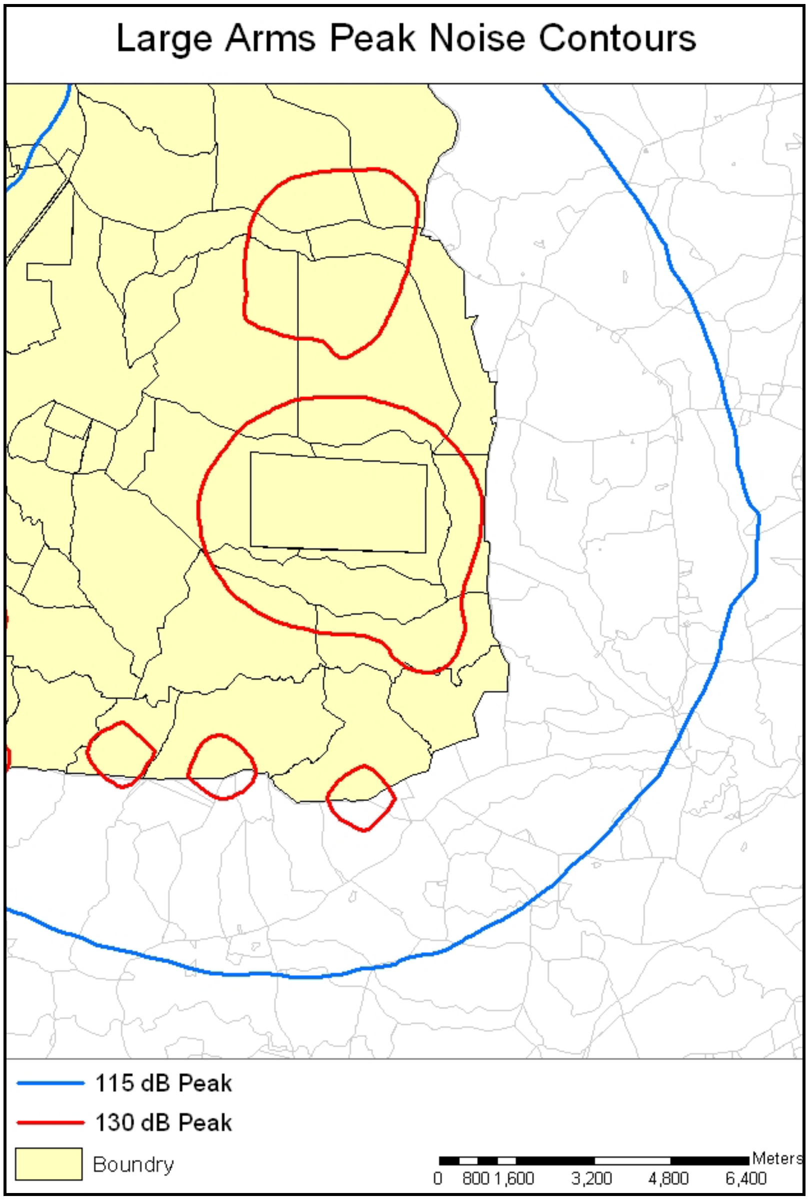

Figure A-5 Example of a Map Showing Peak Noise Contours

A.5.1 COMPUTER PROGRAMS

The relatively simple looking output of a map showing noise contour lines is actually the result of some comparatively complicated computer programs. In fact, most of these programs are in perpetual states of evolution as new data become available and advances in computing power allow for more variables to be factored into creating the final contour.

Table A-2 lists the most popular noise mapping programs and some of their preferred usage characteristics.

Model	Timeframe	Characteristic	Source	Use
NOISEMAP	Long-term	Transient	Fixed-wing aircraft	Airbase noise exposure, AICUZ
Rotorcraft Noise Model	Long-term & single events	Transient	Helicopters and tiltrotors	Airbase noise exposure, AICUZ, range noise
ROUTEMAP	Long-term	Transient	Fixed-wing	MTRs
MR_NMAP	Long-term & single missions	Transient	Fixed-wing	MOA, MTR, Special uses ranges
BoomMap	Long-term	Impulse	Sonic booms	Supersonic MOA ops
BNOISE2	Long-term & single events	Impulse	OD & large guns	Ranges and OD pits
SARNAM	Long-term & single events	Impulse/transient	Small arms	Firing range
MENU10	Single event	Transient	Fixed wing	Flyover noise levels
MENU11	Single event	Transients	Fixed wing	Ground run up noise levels
NMSIM	Single event	Transients	Fixed wing	Subsonic aircraft operations
PCBOOM3	Single event	Impulse	Fixed wing	Sonic boom analysis
SIPS	Single event	Impulse	Blast	Open detonation blast
NAPS	Single event	Impulse	Blast	Open detonation blast
TNM	Long-term	Transient	Road traffic	Highway and road noise exposure
RWNM	Long-term	Transient	Trains and guided rail vehicles	Rail operations, yard and tracks

Table A-2 Noise Models and Their Uses

Regarding the contours featured in Operational Noise Plans created by USACHPPM:

- Small arms noise contours are generated by the Small Arms Range Noise Assessment Model (SARNAM) Version 2.6. This model incorporates the latest available information on weapons noise source models (including directivity and spectrum), sound propagation, effects of noise mitigation and safety structures (walls, berms, ricochet barriers, etc.), and community response protocols for small arms noise. It also includes an extensive selection of weapons in the source library, can handle multiple ranges of various types, and is designed to maximize user productivity.

- Blast noise (i.e., explosions and large arms) contours are generated by the BNOISE2 program, Version 1.3. It accounts for spectrum and directivity of both muzzle blast and projectile sonic boom while also considering issues of propagation including land/water boundaries and terrain.

- Aircraft noise contours are generated by NOISEMAP with inputs of aircraft type, altitude, power setting, speed, and number of operations.

All of the computer models work in generally the same fashion. The weapon type and number of rounds fired is combined with various geographic and atmospheric data (location, direction of fire, weather, etc.). The user then defines which contours he/she wishes to see, the program calculates how far the sound will travel under those conditions, and the resulting contours are then overlaid onto a conventional map of the area.

In spite of the research invested and the intricacies of the programs, it must be said that the outputs of the modeling programs are not always exactly what may be found "on the ground" at any given moment. The problem lies not with the calculations or algorithms, but with the number of variables that practical and computing considerations limit the user to inputting. Put another way, there are far too many variables on the ground (even down to how long the grass is) to ever truly simulate the natural world.

So, when done properly, the contours produced can be relied upon to paint a clear picture of the general noise environment of an area, and show information that is of the integrity needed to make prudent planning and zoning decisions.

Additional information on noise models or contouring procedures can be obtained from the USACHPPM's Operational Noise Group.

A.5.2 WHAT AFFECTS CONTOUR SHAPES?

In an ideal world (for acousticians, anyway), all noise contours would be perfect circles because the noise would travel from the source at the same speed and intensity in every direction. But, the geology, geography, climatology, and physics of our planet create an environment where external forces are acting on sound waves the second they are created. Those waves may be directed by the nature of the source, reflected by a wall, refracted by some mountains, attenuated by winds, intensified by atmospheric conditions, or absorbed entirely by a thick coniferous forest.

All of these situations then ply that theoretically perfect circle, stretching it in some places (e.g., pushing through a mountain gap), and smashing it in others (such as in the direction against a heavy breeze).

A.6 CONCLUSION

The science of measuring and modeling unwanted sounds is constantly evolving, just like the relationships between military installations and the communities that surround them. As defense spending continues to drive innovation and support a large sector of our nation's economy, the weapons are getting more powerful and louder, and population pressures are increasing around once-remote installations.

But, while evolving relationships always pose new challenges, they also always pose new opportunities. Understanding the way sound behaves and utilizing the noise monitoring and modeling tools available are critical to making proper land use decisions in and around installations, so that the installations and the surrounding communities continue to thrive in each other's presence

Appendix B

Operations and Utilization Data for Noise Contours

B.1 SMALL ARMS UTILIZATION

B.1.1 SMALL ARMS NOISE CONTOUR UTILIZATION (North Post)

	PISTOL, 45 CAL, LIVE	PISTOL, 9 MM, LIVE	TRAINER AT4, 9MM TPT	RIFLE, 5.56 MM, LIVE	RIFLE, 5.56 MM, BLANK*	MACHINE GUN, 7.62 MM, LIVE	MACHINE GUN, .50 CAL, LIVE	SHOTGUN, 12 GAUGE
Range1 - CPQC	X	X						X
Range 2 - MPMG				X		X	X	
Range 10 - Zero		X		X				
Range 12 - Anit-tank Subcal			X					
Range 16 - Zero				X		X		
Range 17 - Squad Defense			X	X		X		
Range 18 - MPMG						X		
Range 29 - MPTR				X	X	X	X	
Range 30A - Zero				X		X		
Range 31A - ARF				X				
Range 32 - MRF				X	X			
Range 33 - Zero	X	X		X	X			X
Range 34 - MPMG				X	X	X	X	

B.1.2 SMALL ARMS NON-FIXED FIRING POINT UTILIZATION

	PISTOL, .40 CAL, LIVE	PISTOL, .40 CAL, BLANK*	PISTOL, 9 MM, BLANK*	TRAINER AT4, 9MM TPT	RIFLE, 5.56 MM, LIVE
Range 4 - Convoy Live Fire		X	X	X	X
Range 6 - ISBC			X	X	X
Range 41 - Urban Assualt Course	X				X

B.1.3 SMALL ARMS NOISE CONTOUR UTILIZATION (South Post)

	RIFLE, 5.56 MM, LIVE	RIFLE, 5.56 MM, BLANK*
Range 101 - ARF/KD	X	
Range 102 - Zero	X	X

B.1.4 SMALL ARMS FORECAST RANGE UTILIZATION (South Post)

	PISTOL, .45 CAL, LIVE	PISTOL, 9 MM, LIVE	RIFLE, 5.56 MM, LIVE	RIFLE, 7.62 MM, LIVE	MACHINE GUN, 7.62 MM, LIVE
Range 100 - QTR	X	X	X	X	X
Range 105 - Zero			X		

B.2 LARGE ARMS AND EXPLOSIVE DETONATION DATA

B.2.1 BASELINE AND FORECAST AMMUNITION DATA

Activity Type	Weapon Platform and Ammunition Type	Firing Location	Baseline (Existing) Activity	Forecasted (Future) Activity	Fall Training Activity Authorized
Artillery					
	105mm Howitzer, HE and Inert	Artillery Firing Point 401		√	►
		Artillery Firing Point 402		√	►
		Artillery Firing Point 403		√	►
		Artillery Firing Point 404		√	►
		Artillery Firing Point 405		√	►
		Artillery Firing Point 406		√	►
		Artillery Firing Point 407		√	►
		Artillery Firing Point 408		√	►
		Artillery Firing Point 409		√	►
		Artillery Firing Point 410		√	►
		Artillery Firing Point 411		√	►
		Artillery Firing Point 412		√	►
		Artillery Firing Point 413		√	►
		Artillery Firing Point 414		√	►
		Artillery Firing Point 415		√	►
		Artillery Firing Point 416		√	►
		Artillery Firing Point 417		√	►
		Artillery Firing Point 418	•	√	►
		Artillery Firing Point 420		√	►
		Artillery Firing Point 421	•	√	►
		Artillery Firing Point 422		√	►
	155mm Howitzer, HE and Inert	Artillery Firing Point 401		√	►
		Artillery Firing Point 402		√	►
		Artillery Firing Point 403		√	►
		Artillery Firing Point 404		√	►
		Artillery Firing Point 405		√	►
		Artillery Firing Point 406		√	►
		Artillery Firing Point 407		√	►
		Artillery Firing Point 408		√	►
		Artillery Firing Point 409		√	►
		Artillery Firing Point 410		√	►
		Artillery Firing Point 411		√	►
		Artillery Firing Point 412	•	√	►
		Artillery Firing Point 413	•	√	►
		Artillery Firing Point 414		√	►
		Artillery Firing Point 415	•	√	►
		Artillery Firing Point 416	•	√	►
		Artillery Firing Point 417	•	√	►
		Artillery Firing Point 418	•	√	►
		Artillery Firing Point 420		√	►
		Artillery Firing Point 421	•	√	►
		Artillery Firing Point 422		√	►
MLRS					
	MLRS, Reduced Range Practice Rocket, Inert	Artillery Firing Point 421		√	►
		Cranberry Drop Zone		√	►
		Firing Area 02		√	►

NOTE: Inert is defined as any round that does not create noise upon impact.

Activity Type	Weapon Platform and Ammunition Type	Firing Location	Baseline (Existing) Activity	Forecasted (Future) Activity	Full Training Activity Authorized
Mortar					
	60mm Mortar, HE and Inert	Mortar Point 302		√	►
		Mortar Point 303		√	►
		Mortar Point 304	•	√	►
		Mortar Point 304		√	►
		Mortar Point 305		√	►
		Mortar Point 306		√	►
		Mortar Point 307		√	►
		Mortar Point 309		√	►
		Mortar Point 310		√	►
		Mortar Point 311		√	►
		Mortar Point 312	•	√	►
		Mortar Point 312		√	►
		Observation Point 31A	•	√	►
		Artillery Firing Point 405	•	√	►
	81mm Mortar, HE and Inert	Mortar Point 302		√	►
		Mortar Point 303		√	►
		Mortar Point 304	•	√	►
		Mortar Point 305	•	√	►
		Mortar Point 306		√	►
		Mortar Point 307	•	√	►
		Mortar Point 309		√	►
		Mortar Point 310		√	►
		Mortar Point 311		√	►
		Mortar Point 312		√	►
		Observation Point 31A	•	√	►
	120mm Mortar, HE and Inert	Mortar Point 310	•	√	►
Gun					
	20mm Gun, Inert	Range 29 MPTR		√	►
	25mm Gun, Inert	Range 02A	•	√	►
		Range 04 CLF			►
		Range 29 MPTR			►
	30mm Gun, Inert	Range 29 MPTR			►
	105mm Styker Tank Gun, Inert	Range 02A			►
		Range 29 MPTR			►
	120mm Tank Gun, Inert	Range 02A			►
		Range 29 MPTR			►

Activity Type	Weapon Platform and Ammunition Type	Firing Location	Baseline (Existing) Activity	Forecasted (Future) Activity	Full Training Activity Authorized
Grenade					
	40mm Grenade HE	Range 29A Anti-tank	•	√	►
		Range 35	•	√	►
	Hand Grenade, M67, HE	Range 08	•	√	►
Rocket/Missile					
	Shoulder fired Rockets, Inert	Range 04 CLF			►
		Range 06	•	√	►
		Range 29 MPTR			►
	Shoulder fired Rockets, HE	Range 29A Anti-tank	•	√	►
	TOW Missile, Inert	Range 29 MPTR	•	√	►
	2.75" Rocket, Inert	Range 29 MPTR			►

Baseline Activity:	Baseline noise contours are the "normal" operations at your installation by your assigned units or those units that routinely use your facility. The baseline contours are to show the current/typical noise environment in your community.
Forecasted Activity:	Forecasted noise contours are your baseline activity plus specific proposed actions. Such as a new range or gain/loss of units (e.g. losing a HBCT, gaining two IBCT, or realignment to a FA unit).
Full Training Activity Authorized:	These complaint risk contours were developed to depict "the greatest extent of the operational footprint of all authorized activity at Fort McCoy". Some of the activity authorized does not occur on a routine basis, such as 200 lb demolition charge.

Activity Type	Type	Net Explosive Weight	Firing Location	Range Limitation	Baseline (Existing) Activity	Forecasted (Anticipated) Activity	Full Training Activity Authorized
Demolition							
	Bangalore Torpedo, 2 sections	20 lbs	Range 04 CLF	Bangalore Torpedo: limit 2 sections			▶
	Claymore Mine	1.5 lbs		NEW not to exceed __lbs per charge			▶
	Bangalore Torpedo, 2 sections	20 lbs	Range 06	Bangalore Torpedo: limit 2 sections NEW not to exceed __lbs per charge			▶
	Claymore Mine	1.5 lbs					▶
	TNT	1 lb			•	√	▶
	C4	10 lbs	Range 11	NEW not to exceed 10 lbs per charge			▶
	Dynamite	10 lbs					▶
	TNT	10 lbs					▶
	Claymore Mine	1.5 lbs	Range 17	NEW not to exceed __lbs per charge			▶
	Bangalore Torpedo, 2 sections	20 lbs	Range 17A	Bangalore Torpedo: limit 2 sections	•	√	▶
	C4	1.25 - 2.5 lbs			•	√	▶
	H6	3.5 lbs			•	√	▶
	APOBS	51 lbs			•	√	▶
	Cratering Charges	56 lbs		NEW not to exceed 200 lbs per charge	•	√	▶
	Shape Charges	0.07 - 15 lbs			•	√	▶
	Tovex Water Gel	0.5 lbs			•	√	▶
	C4	200 lbs					▶
	Bangalore Torpedo, 2 sections		Range 29 MPTR	Bangalore Torpedo: limit 2 sections			▶
	Claymore Mine	1.5 lbs		NEW not to exceed __lbs per charge			▶
	Bangalore Torpedo, 2 sections	20 lbs	RRAS (Rapid Repair Air Strip)	Bangalore Torpedo: limit 2 sections			▶
	C4	1.25 lbs		NEW not to exceed 150 lbs per charge	•	√	▶
	Dynamite						▶
	TNT						▶
	Shape Charges						▶

Baseline Activity:	Baseline noise contours are the "normal" operations at your installation by your assigned units or those units that routinely use your facility. The baseline contours are to show the current/typical noise environment in your community.
Forecasted Activity:	Forecasted noise contours are your baseline activity plus specific proposed actions. Such as a new range or gain/loss of units (e.g. losing a HBCT, gaining two IBCT, or realignment to a FA unit).
Full Training Activity Authorized:	These complaint risk contours were developed to depict "the greatest extent of the operational footprint of all authorized activity at Fort McCoy". Some of the activity authorized does not occur on a routine basis, such as 200 lb demolition.

Appendix C

Guidelines for Discussing Noise Contour Maps

C.1 INTRODUCTION

Noise contour maps are the best way to show where noise is likely to go and at what intensity. Though much effort has been put into the creation of the computer programs that generate the noise contours, putting a highly variable concept onto a 2-dimensional piece of paper is a precarious science. Often, people viewing a noise contour map erroneously assume that the simplicity of the medium (i.e., the piece of paper) equates to the relative difficulty of the subject. The fact is, all of the intricacies of sound cannot be completely and accurately be portrayed in such a simplistic manner, but noise contour maps are the best way available and are quite effective if explained properly.

Note: If one is going to be charged with explaining noise contours (or any other potentially controversial subject) to the public on a regular basis, it is advised that the individual take a class in risk communication.

C.2 PREPARATION

Preparation is the primary ingredient needed to get any message across to an audience. Logically, one must first understand the message themselves before they can expect to credibly deliver it to anyone else.

It is not required that an individual be an expert on every aspect of the creation of the map. But, the concept of credibility (which will be a recurring theme in this Section) depends upon the presenter being knowledgeable and trustworthy. Proper preparations should include:

- Knowing inside and out the meaning of a particular set of contours (i.e., what the noise contours <u>do</u> say, and what they <u>do not</u> say).
- Familiarizing oneself with the basics of sound, how it travels, what effects that travel, and the relationship between sound and annoyance.
- Familiarizing oneself with the computer modeling and Geographic Information System (GIS) applications used to create the contours and maps.
- Learning about the concerns and/or biases of the audience.

Establishing credibility allows for the audience to trust your facts and helps bridge the gap in understanding that skepticism can create.

C.3 MEANING OF THE CONTOURS

A primary source of misunderstanding is how the contours are "interpreted." In reality, the contours are a stark picture of what is happening based on the parameters that have been input into the models, not an artist's rendition. Consequently, there is only one way to "read" the contours. Interpretation becomes a factor only when members of the audience are deciding if what the contours say is a good or a bad thing.

C.3.1 WHAT NOISE CONTOURS *CAN* TELL US

Noise contours are best at advising people of the approximate distribution of the noise coming from a particular source; in this case, military installations. Accordingly, if a person feels that there may be a chance that they are noise-sensitive, the contour map can give that individual an idea of where it might not be best for he/she to live.

Also, noise contours are excellent for making comparisons between the noises generated under one set of circumstances to those generated under another. This is especially useful when deciding such things as under what weather conditions it is best to train, whether a proposed location would work well for a new range, or to what degree troop deployments/reassignments will impact the surrounding areas.

C.3.2 WHAT NOISE CONTOURS *CANNOT* TELL US (WITH CERTAINTY)

Anyone explaining noise contours should first and foremost be aware that the noise levels do not stop at the line on the map. Most contours are averages of some sort and these averages are necessary because the infinite number of physical and meteorological variables at any given location would require an equally infinite number of maps to show them all. Thus, contours are representations of what someone is likely to experience under a given set of circumstances, and they cannot say that it is too loud for an assisted living center on one side of the road but not the other.

Also, it must be pointed out that contours change (sometimes often) due to weather, training schedules, deployments, technologies, etc. And, though what is shown on a map has a built in level of conservatism, it by no means suggests that things will never be louder or quieter at a given location.

Furthermore, contours cannot say whether or not the amount of noise shown to be in a particular area is going to be bothersome; this is up to individuals to decide and is a product of many variables. For instance, a relatively modest sound level at a house that is located next to a busy street is likely to be accepted quite differently than the same sound level at a house located on a canyon ridge all by itself.

In short, noise contours deal only with noise generalities and cannot reliably give information beyond noise (e.g., predict that houses "here" are worth more or less than houses over "there").

C.4 THE BASICS OF SOUND AND ANNOYANCE

Explaining the limits of the noise contours inevitably generates questions regarding why it is so difficult to pin down exactly where noise is going to travel and at what levels. The answer is that the propagation of sound and human perceptions of sound are dependent on so many variables that it impossible to cement exactly what will irritate a particular person.

The physical propagation of sound is affected by weather, terrain, distance, barriers, and the nature of the sound itself (i.e., different frequencies have different travel characteristics). In fact, weather has a profound affect on the degree to which a sound "lands" at a particular location, and that is of course a variable that can literally change from hour-to-hour. Appendix A gives a more in-depth description of the science of sound.

Human perception is even more challenging to account for on a single map. From county to county, ZIP code to ZIP code, and house to house, people's ideas of when a sound becomes noise can differ markedly. These differences in perception can be attributed to such varied sources as:

- The physical state of the individual's hearing ability (i.e., is the individual's hearing health good or bad?)
- Past experiences (i.e., could the individual have experienced trauma in the past that makes them particularly sensitive to loud or sharp sounds?)
- Attitude toward the noise source (i.e., does the receiver dislike the military?)
- General temperament (i.e., is the individual "jumpy?")

By understanding the relationship between the physical behavior of sound and some of the human variables that can turn a sound into a noise, we can paint a clearer picture to an audience about how they can each use the noise contours to make the decisions that best suit their individual situations.

C.5 COMPUTER MODELS AND GIS

It is also difficult to explain with any validity what the noise contours mean if one knows nothing about the process that created them.

The specific process of creating noise contours varies by what is creating the noise and, accordingly, which model is used to make the picture. But, the general idea is that pertinent information (such as the item making the noise, its location, the direction of fire/travel, weather conditions, etc.) is entered into the appropriate computer model, the model outputs a picture based on the noise metric specified, and then that picture is imported into a GIS program so that a map can be created.

However, while the computer models used by the military are some of the best available, they do have important limitations. First, no matter how sophisticated, no model can take into account every terrain variable at a given location unless models were specifically developed for every installation (which would cost an enormous amount, if it were even possible). Second, the databases of noise producers in the models are representative of the military's equipment, but may not contain individual specifications for every variety of a particular piece of equipment.

So, taken together, these two limitations further prevent the resolution of the noise contours from reaching the "street level," and they advance the idea that noise sensitive persons must take into consideration all available information before making a choice that may conflict with an existing noise environment (such as buying a home next to a highway or military installation).

In summary, taking the time to explain how the models work will draw an audience's expectations more toward what the computer models can actually provide.

C.6 AUDIENCE

While it has been mentioned previously that the information on a noise contour map is absolute and not necessarily up to interpretation, the type of audience to whom one is presenting noise contour information has an enormous impact on exactly how that information should be presented. For example, the social atmosphere created by a group of installation commanders is likely to be far different than the atmosphere in a meeting of developers and county planners.

So, most audiences are going to be biased in one way or another. But, when the interests of a particular group are at odds with the interests of the military, a hostile atmosphere could be the product. Here, it must be remembered that these things are rarely personal—most of the time the individuals do not dislike the presenter or the government, they are simply concerned about their business or livelihoods.

In all cases, the best practice is to keep a professional appearance and demeanor, and stick to the facts. The presenter should answer only the questions she/he knows, and jot down the questions she/he does not know with the promise that the participant will be contacted with the answer in a timely manner. Additionally, while it is best to keep the atmosphere light, it is important that an audience is comfortable that their concerns are being taken seriously

C.7 CONCLUSION

By and large, people are either apathetic or fearful of things they do not understand, neither of which is good when it comes to issues involving noise.

On the one hand, the military does not want citizens or installation personnel not caring about issues of noise, because this eliminates the interest that is required to solve problems proactively. On the other hand, fearful individuals tend to overreact and further complicate a situation. The ideal state is one where an informed and concerned military does everything it can to mitigate noise impacts while still performing its Constitutionally-charged mission, and an informed and concerned public makes land use decisions that are compatible with that noise environment.

To that end, the way in which noise contours are presented (and to whom) can go along way toward a state where installations and the public work together to each other's mutual benefit.

Remember: in risk communication, one has successfully conveyed the seriousness of a situation when they have raised the alarm of the Unconcerned, and calmed the Overly-concerned to the rational level of awareness that the particular situation deserves.

Appendix D
Land Use Planning and Control Techniques

D.1 GENERAL

Several different planning and land use control techniques are available to local governments to ensure that compatible uses are located in and around areas of unique characteristics (such as the lands that border military installations). Some are more specialized than others, but wielded properly, every one of the following tools has the capability to limit the possibility of complaints due to encroachment.

D.2 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.

- **Uses of Zoning.** Zoning should be applied fairly and based on a comprehensive plan that considers the total needs of the community along with the specific needs of the installation. For example, it is not acceptable to zone a parcel of land for industrial or warehouse usage simply because it lies within a noise impact area. Such an action could be considered "arbitrary, capricious, or unreasonable" and thus be vulnerable in the event of judicial review; zoning plans must clearly demonstrate that there is a reasonable present or future need for such usage. However, if it can be clearly shown that the proposed zoning is being used constructively to increase the value and productivity of land within noise impacted areas, it is the preferred method of controlling land use.

- **Limitations of Zoning.** Zoning has several limitations that must be considered when using it as a compatibility implementation device. These limitations include the following:

    - <u>Zoning is usually not retroactive.</u> That is, changing a zone for the primary purpose of prohibiting a use that already exists is normally not possible. And even if such a change is successful, the existing uses that have been rendered unlawful must remain as "nonconforming" elements until the owner has had ample time to recoup his/her investment.

    - <u>Zoning is jurisdiction-limited.</u> Installation impacts often span more than one zoning jurisdiction. In these cases, zoning requires the coordination of all involved jurisdictions in order to be effective. Zoning that implements a compatibility plan will often be composed of existing and new zoning districts within each of the zoning jurisdictions covered by the plan. Further complicating matters, each jurisdiction is likely to have a different base zoning ordinance requiring different actions for implementing the compatibility plan. Also, counties in many states do not have any zoning authority at all, so land use control via zoning in these states stops at the municipal boundary.

- Zoning is **not** permanent. In any jurisdiction, zoning can be changed by the current government body; it is not bound by prior zoning actions. Consequently, even if zoning achieves compatibility, that compatibility is continually pressured by both urban expansion and enterprises that might profit from a favorable zoning change.

- Cumulative zoning can permit incompatible development. Several communities around the country employ "cumulative"-type zoning districts that permit all "higher" uses (such as residential) in "lower" use districts (such as commercial or industrial), thus supporting development that may be incompatible. In these instances, it is necessary to prepare and adopt new or additional zoning districts of the "exclusionary" type (i.e., that clearly specify the uses permitted and exclude all others).

- Zoning Board of Adjustment actions granting variances. Variances to the zoning district of exceptions (e.g., schools or churches) written into the zoning ordinance can also permit development that may be incompatible.

- **Positive Features of Zoning.** The zoning ordinance may be the most attractive land use control to prevent development around installations because it is effective (prohibiting specific development by law) and normally costs the installation nothing.

- **Negative Features of Zoning.** The installation must rely on the municipality's governing body for proper zoning solutions which may entail political struggles beyond the installation's control. Also, the municipality must be wary of "taking land without compensation," which is a citizen's rights issue that is often raised in zoning proceedings.

D.3 OVERLAY DISTRICTS

An overlay district is generally defined as any specially mapped district which is subject to supplementary regulations or requirements for development. Overlay districts, by either adding restrictions to or removing restrictions from the underlying zoning, provide specific provisions designed to address issues unique to a particular geographic area. They are used to curb discordant development in places where a specific resource (cultural, economic, or environmental) is in jeopardy.

The following are some examples of situations that may garner the creation of an overlay district:

- Neighborhood/Historic Area Preservation
- Focused Economic Development – targeted revitalization areas, business parks, etc.
- Natural Resource Protection – watersheds, aquifers, wildlife corridors, etc.
- Infrastructure Protection – airports, military bases, cultural districts, etc.
- Specific Plans – university districts, cultural districts, etc.

The provisions set forth in an overlay district can regulate any number of things from construction materials or styles (to better fit a historical district or provide for noise protection next to an airport), to business types and practices (in order to protect something like a reservoir).

- **Positive Features of Overlay Districts.** Allow great regulatory flexibility to be assigned to a very specific area so that any inconvenience affects the fewest number of people possible. Also, cost the local government and sponsoring party very little to implement.

- **Negative Features of Overlay Districts.** Must be approved by community/city council and is subject to public hearings. Implementation is also subject to local political climate and public perception/attitudes.

D.4 EASEMENTS

Easements can be an effective and permanent form of land use control; in many instances, better than zoning when trying to resolve and installations 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. Another consideration is that the land is left free for full development with noise-compatible uses.

- **Definition.** An easement is the right of another to part of the total benefits of the real property owner. When dealing with the laws of property in this country, ownership of property includes possession of a series of rights to the use of that property. Certain rights to the property are always retained by the state or the general public (e.g., police power, taxation, eminent domain, escheat, etc.), and certain rights are retained by the neighboring property owners (e.g., the flow of water across land). But, the owner controls the rest of the rights to build, log, mine, etc. Usually when property is acquired, all of the rights are purchased (i.e., in fee simple). However, it is possible to buy only the selected rights that are actually needed in the form of easements. The cost of an easement is determined by the value of those rights to the land owner. If the easement will not adversely affect the owner's contemplated usage or sale of the land, the price will be low; if it does, the price will be higher.

  There are two basic classes of easements: positive and negative. In positive easements, the right to do something with the property (such as build a road) is acquired. In negative easements, the rights are acquired to prevent the owner of the property from doing something (such as erecting billboards). For issues of noise compatibility, both a positive easement to make noise over the land and the negative easement to prevent the creation of an unprotected noise-sensitive use on the property may need to be acquired to ensure adequate control.

- **Obtaining Easements.** Easements can be obtained in several ways including purchase, condemnation, and dedication. For each easement required, it is wise to include a legal description of the noise that may be created over the property and the classes of uses that may be established or maintained with and without soundproofing.

- **Positive Features of Easements.** Easement purchases are very straightforward transactions and are almost always less expensive than fee-simple purchases. They allow the installation to retain control over adjacent land without the burden of actual ownership, and they are also usable in cases for which development already surrounds the installation.

- **Negative Features of Easements.** There may be difficulty in getting the cooperation necessary to obtain easements, particularly when many land owners are involved. Also, unless otherwise specified, the rights are not automatically transferred upon resale of the land, so future negotiations may be required.

D.5 TRANSFER OF DEVELOPMENT RIGHTS (TDR)

Under the TDR concept, some of the property's developmental rights are transferred to a remote location where they may be used to intensify allowable development. So, for example, lands within an installation's noise-impacted area could be kept in open space or agricultural areas, and their developmental rights for residential uses transferred to more appropriate locations. In this system, land owners are compensated for their rights at market value, and the purchaser either holds the rights or recoups the investment when houses are built and sold using the rights. The TDR approach must be fully coordinated with the community's planning and zoning office, and it may be necessary for the zoning ordinance to be amended so that it permits TDRs. Also, transfers usually must be contained within single zoning jurisdictions.

- **Positive Features of TDRs.** The program itself is inexpensive or cost-free to the installations because it is administered by the local governments, and it may stimulate development in the areas to which the rights are being transferred.

- **Negative Features of TDRs.** One potential problem is record keeping. Because of the complexity of the transactions, it is often difficult to keep track of the principals and the exact number of rights that are sold and bought. Nevertheless, it can be done and this system is currently in place in Harford County, Maryland—the home of Aberdeen Proving Ground—and many others.

D.6 LAND PURCHASE

Fee-simple purchase of noise impacted land is the most positive form of land use control, but it is also the most expensive. It must be kept in mind though that, while the costs may seem excessive on the surface, the net cost may be reduced substantially with either resale for compatible uses or retention and use for a compatible public purpose. As a preventive measure, purchase should be mostly limited to critical locations and to situations where other solutions are not feasible.

- **Positive Features of Land Purchase.** Allows installation complete control over the use of the land including sale at a later date.

- **Negative Features of Land Purchase.** The biggest problem with this method is that the initial cost of acquiring the land may be too great to justify. Additionally, the cost of maintaining the land in the future must be factored into to any cost projections.

D.7 BUILDING CODES

A building code prescribes the basic requirements that regulate the construction of structures. It is adopted by the local governing body to protect the health, safety, and general welfare of the occupants of these structures through the establishment of a set of minimum requirements for fire resistance, strength, ventilation, plumbing, etc. Although codes are not a technique to actually prevent development, if properly conceived they can effectively restrict it near military installations by requiring structures to be constructed to a particular standard of sound transmission.

- **Positive Features of Building Codes.** If development is imminent, utilizing the building code ensures that at the very least new structures will be constructed with a certain level of inherent sound proofing.

- **Negative Features of Building Codes.** Building codes do not prevent or restrict any type of actual land use around an installation.

D.8 SUBDIVISION REGULATION

Subdivision regulations are a means by which local government 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.

- **Positive Features of Subdivision Regulations.** The regulations can be used to judiciously locate areas of open space to create buffers between noise sources and receivers.

- **Negative Features of Subdivision Regulations.** Subdivision regulations are only a way to diminish the impact of noise emanating from an installation; they alone will not prevent development around an installation. Also, depending on the scope of the development plans, the buffers created may not be large enough to adequately cut the noise levels.

D.9 HEALTH CODES

The heath code in a given community establishes the requirements that protect residents from elements that may endanger them such as poor sanitation and inadequate drinking water supplies. Health codes encompass all types of land use but, like building codes, they cannot directly prevent development around military installations. Health codes can, however, protect people from noise impacts if a standard is built into the code that requires a developer to prohibit excessive noise levels in the development or consider other uses that are not noise-sensitive.

- **Positive Features of Health Codes.** The heath code could be used in areas where zoning is either not used or not an option. In most cases, the health code can be made strict enough to disallow residential uses near installations (thus limiting land use to something more compatible such as a manufacturing plant).

- **Negative Features of Health Codes.** The health code, depending on its complexity, is often difficult to administer. Also, the paperwork and field checks required to ensure compliance can be costly to a local government and slow development.

D.10 DISCLOSURE OF NOISE LEVELS

Since noise levels in a community can be measured and recorded, making information about the true noise levels around military installations can sometimes be all it takes to discourage some incompatible uses. These noise levels can be disclosed in several ways including ordinances (or amendments to existing ordinances), including noise levels in the deed, 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 maps.

- **Positive Features of Disclosing Noise Levels.** These programs make easily available to the public information that is otherwise difficult to obtain (particularly for those new to the area), making it easier to make an informed choice about where to live.

- **Negative Features of Disclosing Noise Levels.** Simply disclosing noise levels does not ensure that the information will be used, and programs will be required to educate the public and ensure that the information remains current and available. Moreover, these measures could become costly and time-consuming if noise contours were required to be placed on all municipal maps.

D.11 LAND BANKING

Land banking is when a government acquires a substantial fraction of land in a region available for future development for the purpose of implementing a public land use policy. Banking differs from permanent acquisition in that it places the land in a temporary holding status to be turned over for development at a future date.

- **Positive Features of Land Banking.** The two primary arguments in favor of land banking are that it has an anti-inflationary effect in land prices (preventing land speculation), and it will permit more rational patterns of development rather than urban sprawl.

- **Negative Features of Land Banking.** There is not total agreement that land banking is effective. Additionally, beginning a land banking program requires a large expenditure (though this money is recovered when the land is ultimately sold) and there is the possibility that the program can become politically influenced.

D.12 SPECIAL TAX TREATMENT

Whether through full tax exemption, preferential assessment, or deferrals, special tax treatment by a local government can provide owners of land around military installations with incentives to keep land uses on their property compatible with the noise environment.

- **Positive Features of Special Tax Treatment.** Special tax treatments are particularly desirable because there is no cost to the military. Additionally, when existing uses are politically popular (such as farming), support becomes easier to garner. A side benefit is the fact the properties adjacent to the focus of the tax treatment often increase in value (due to lowered supply and the desire of some to locate next to farms or other open space) and that this may actually translate to increased tax revenue for the local government.

- **Negative Features of Special Tax Treatment.** The cost of the program must be absorbed by the local government and it may not be willing to accept a diminished tax revenue stream, even if only temporarily.

D.13 CAPITAL IMPROVEMENTS PROGRAM (CIP)

A capital improvements program (CIP) is a planning tool used by local jurisdictions to prioritize the construction or improvement of needed public facilities (e.g., water and sewer systems, roads, schools, etc.). Since development often follows to where capital improvements have been made, if local governments avoid making capital improvements near military installations, it discourages development by forcing developers to shoulder more costs of the project, sometimes making the return in investment not worthwhile.

- **Positive Features of CIP.** Using the local CIP to discourage development is attractive because it is effectively asking the local government not to do something that is quite expensive, so financially it is not a hard sell.

- **Negative Features of CIP.** The local government may be intent on investing in new capital spending to encourage enlargement of the tax base, and thus may be unwilling to suspend such an initiative at the request of the installation

D.14 DEVELOPMENT LOAN RESTRICTIONS

To fund projects, developers often need to borrow money from lending institutions—if the funds cannot be obtained, the development cannot occur. Consequently, restricting or prohibiting mortgage and/or other loans for certain land uses is a way to control development. For instance, state and local governments could designate areas around military installations (coinciding with certain noise contours) for which banks and other lending institutions are prohibited from making loans.

- **Positive Features of Development Loan Restrictions.** The attractive feature of the program is that it costs nothing for the local government to implement yet still prevents development effectively.

- **Negative Features of Development Loan Restrictions.** These programs usually cannot be implemented immediately because it is quite possible that lending institutions will sue the local government for not allowing then to use their money as they see fit.

D.15 PUBLIC/PRIVATE LEASEBACK

Leaseback is a financial arrangement that can be used in both the public and private sectors whereby land is acquired and controlled, but not necessarily occupied, by the owner. In scenarios involving the prevention of encroachment, ideally the owner of the land can be encouraged to lease the land to a user who will employ it in ways that are compatible with the noise environment. This way, the owner gains stable income from his/her land (leases typically run from 20 to 40 years), but its uses are still checked.

- **Positive Features of Public/Private Leaseback.** Leaseback offers a way for public agencies to acquire land, offset the cost with the income from the lease, and provide for the compatible, continued use of land by others.

- **Negative Features of Public/Private Leaseback.** Owners often have the usual landlord's management problems, and the local government may be denied tax revenue if the land is used by the public sector.

D.16 SALES AGREEMENT

An essential ingredient in transferring real estate into a valuable commodity is a legally binding written sales agreement to establish the terms agreed upon by the buyer and seller. An installation, through sales agreements, can restrict the use of surrounding lands if they own or control them.

- **Positive Features of Sales Agreements.** After signing, the sales agreement is a legally binding contract, and either of the parties can seek legal recourse through the legal system if the contract is broken.

- **Negative Features of Sales Agreements.** Unlike the restrictive covenant, the sales agreement pertains only to the prospective buyer, so terms do not carry over to future sales of the property unless so stated in the contract. In addition, certain areas of agreements and contracts are subject to misrepresentation and fraud.

D.17 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 (usually 20-30 years).

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.

- **Positive Features of Deed Restrictions/Covenants.** This method is attractive because it allows the installation to retain control over surrounding land uses without needing to continue ownership of the land (thus lessening the tax burden). Deed restrictions are legally enforceable no matter how many times the property is sold.

- **Negative Features of Deed Restrictions/Covenants.** This method requires convincing those in charge that it is necessary to purchase more land than is directly needed, even if it is to be resold shortly thereafter. Also, though rare, there have been cases where courts have declared covenants unreasonably restrictive or impractical and allowed them to be removed by the land owner.

D.18 PURCHASE OF DEVELOPMENT RIGHTS

A title to real property contains several rights, including that of development. So, by purchasing this single right of development, a military installation can effectively prevent incompatible development by taking away anyone else's chance to build on the land; all at a cost that is considerably less than that of purchasing an entire parcel outright. A program of purchasing development rights works best when the development rights of agricultural lands are the primary focus; the installation protects itself and the land remains productive.

- **Positive Features of Purchasing Development Rights.** While development rights are usually the most expensive rights a parcel of land has, purchasing them is still usually less expensive than purchasing the parcel outright and it may yield the same results. Also, there are no ongoing administrative costs once all of the purchases have been made and the military is not responsible for the upkeep of the land.

- **Negative Features of Purchasing Development Rights.** The money required for such programs is usually front-loaded so obtaining the large lump-sums for purchasing the rights may be difficult. Also, if the best use of the land happens to be something like high density residential, the cost of the rights may not be appreciably less than that of fee-simple ownership.

D.19 EMINENT DOMAIN

Eminent domain is a police power that enables governments to condemn private property in order to acquire it (and all its rights) for a public use. When a government exercises eminent domain, it is basically forcing an owner to sell his/her property for just compensation (determined by independent appraisals), regardless of the owner's desires. It is usually implemented as a last resort when property cannot by acquired or controlled by other methods.

- **Positive Features of Eminent Domain.** Like other acquisition methods, eminent domain allows the government to own full rights to the property.

- **Negative Features of Eminent Domain.** Eminent domain has three primary drawbacks. First, since it is based on fair compensation to the owner, it requires basically the same amount of funding as would buying the property on the free market. Second, when the government takes land from unwilling sellers, the proceedings often result in protracted litigation and adverse publicity. Third, it is sometimes difficult to prove that the public benefit of taking the land is great enough to warrant taking it from an individual.

D.20 PURCHASE OPTION

A purchase option is an agreement whereby the seller agrees to hold the property for a specified time and, in turn, the buyer agrees to pay a sum of money as consideration for that offer. At the time the option is granted, no real property ownership rights pass. Instead, the buyer is purchasing the right to buy at a fixed price within a specified period of time and the seller retains the money paid regardless of whether the option is exercised. This option can be used when funds cannot be immediately acquired to purchase this property outright or if more time is needed to explore possibilities such as rezoning.

- **Positive Features of Purchase Options.** As mentioned above, an option can allow the buyer time to locate and secure the funds necessary to make the final purchase.

- **Negative Features of Purchase Options.** This technique requires the expenditure of funds to purchase the option, and that money is lost if the installation is unable to complete the purchase of the property itself.

Appendix E

FICUN GUIDELINES FOR CONSIDERING NOISE IN LAND USE PLANNING

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+
10	**RESIDENTIAL**							
11	Household Units	yes	yes*	25[1]	30[1]	no	no	no
12	Group Quarters	yes	yes*	25[1]	30[1]	no	no	no
13	Residential Hotels	yes	yes*	25[1]	30[1]	no	no	no
14	Mobile Home Parks or Courts	yes	yes*	no	no	no	no	no
15	Transient Lodgings	yes	yes*	25[1]	30[1]	35[1]	no	no
16	Other Residential	yes	yes*	25[1]	30[1]	no	no	no
20, 30	**MANUFACTURING**							
21	Food & Kindred Products	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
22	Textile Mill Products	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
23	Apparel/Other Finished Products	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
24	Lumber & Wood Products	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
25	Furniture and Fixtures	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
26	Paper & Allied Products	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
27	Printing, Publishing & Allied Industries	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
28	Chemicals & Allied Products	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
29	Petroleum Refining & Related Industries	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
31	Rubber & Misc Plastic Products - Manufacturing	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
32	Stone, Clay & Glass Products - Manufacturing	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
33	Primary Metal Industries	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
34	Fabricated Metal Products - Manufacturing	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
35	Professional, Scientific & Controls	yes	yes	yes	25	30	no	no
39	Miscellaneous Manufacturing	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
40	**TRANSPORTATION, COMMUNICATION & UTILITIES**							
41	Railroad, Rapid Rail Transit & Street Rail	yes	yes	yes	yes[2]	yes[3]	yes[4]	yes[4]
42	Motor Vehicle Transportation	yes	yes	yes	yes[2]	yes[3]	yes[4]	yes[4]
43	Aircraft Transportation	yes	yes	yes	yes[2]	yes[3]	yes[4]	yes[4]
44	Marine Craft Transportation	yes	yes	yes	yes[2]	yes[3]	yes[4]	yes[4]
45	Highway & Street Right-of-Way	yes	yes	yes	yes[2]	yes[3]	yes[4]	yes[4]
46	Automobile Parking	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
47	Communications	yes	yes	yes	25[5]	30[5]	no	no
48	Utilities	yes	yes	yes	yes[2]	yes[3]	yes[4]	yes[4]
49	Other Transportation, Communications & Utilities	yes	yes	yes	25[5]	30[5]	no	no

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		Noise Zone I		Noise Zone II		Noise Zone III		
		0-55	55-65	65-70	70-75	75-80	80-85	85+
50	**TRADE**							
51	Wholesale Trade	yes	yes	yes	yes[2]	yes[3]	yes[4]	no
52	Retail Building Materials, Hardware/Farm	yes	yes	yes	yes[2]	yes[3]	yes[4]	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 and Drinking Facilities	yes	yes	yes	25	30	no	no
59	Other Retail Trade	yes	yes	yes	25	30	no	no
60	**SERVICES**							
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 [11]	yes	yes	yes	yes[2]	yes[3]	yes[4]	yes[6]
63	Business Services	yes	yes	yes	25	30	no	no
64	Repair Services	yes	yes	yes	yes[2]	yes[3]	yes[4]	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
70	**CULTURAL, ENTERTAINMENT & RECREATION**							
71	Cultural Activities, 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[7]	yes[7]	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

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+
80	**RESOURCE PRODUCTION & EXTRACTION**							
81	Agriculture (Except Livestock)[11]	yes	yes	yes[8]	yes[9]	yes[10]	yes[10]	yes[10]
81.5 to 81.7	Livestock Farming & Animal Breeding	yes	yes	yes[8]	yes[9]	no	no	no
82	Agriculture Related Activities[11]	yes	yes	yes[8]	yes[9]	yes[10]	yes[10]	yes[10]
83	Forestry Activities & Related Services[11]	yes	yes	yes[8]	yes[9]	yes[10]	yes[10]	yes[10]
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

Legend:

SLUCM	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
NLR	Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.
Yes[x]	"Yes," but with restrictions. See footnotes.
25, 30, 35	Land use and related structures generally compatible; measures to achieve NLR of 25, 30, or 35 must be incorporated into the design and construction of the 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.

Footnotes:

* The designation of these uses as "compatible" in this zone reflects individual Federal agencies' consideration if 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 indication 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 (in 65-70 ADNL areas) and 30 dB (in 70-75 ADNL areas) 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 15dB 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[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.

X[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.

X^4	Measures to achieve NLR of 35 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
X^5	If noise-sensitive, use indicated NLR; if not, use is compatible.
X^6	No buildings.
X^7	Land use compatible provided special sound reinforcement systems are installed.
X^8	Residential buildings require an NLR of 25.
X^9	Residential buildings require an NLR of 30.
X^{10}	Residential buildings not permitted.
X^{11}	In areas with an ADNL greater than 80, land use not recommended. But, if a community decides use is necessary, hearing protection devices should be worn by personnel.

Appendix F
AR 200-1, Operational Noise Section; DODI

F.1 ARMY REGULATION 200-1 NOISE SECTION (2007)

Chapter 14 Operational Noise
14-1. Policy.
a. Evaluate and document the impact of noise produced by ongoing and proposed Army actions/activities and minimize annoyance to humans to the extent practicable.
b. Develop installation noise management plans as appropriate.
c. Reduce noise to acceptable levels in on-post noise sensitive locations (e.g., medical treatment, education, family housing) through appropriate land use planning and/or architectural and engineering controls.
d. Monitor, record, archive and address operational noise complaints.
e. Develop and procure weapons systems and other military combat equipment (e.g., electrical generators, etc.) that produce less noise, when consistent with operational requirements. Measure the noise emitted by all combat equipment and weapons systems to be used in training before deployed to units.
f. Procure commercially manufactured products, or those adapted for general military use that produce less noise, and comply with regulatory noise emissions standards.
g. Acquire property only as a last resort to resolve off-post noise issues.
h. Manage operational noise issues and community relations to maintain sustainable testing and training capabilities and prevent encroachment.

14-2. Legal and Other Requirements.
Property and tort law; Noise Control Act of 1972, Quiet Communities Act of 1978; AR 95-1; AR 210-20; AR 350-19; and applicable State and local laws.

14-3. Major Program Goals.
a. Control operational noise to protect the health and welfare of people, on- and off- post, impacted by all Army-produced noise, including on- and off-post noise sources.
b. Reduce community annoyance from operational noise to the extent feasible, consistent with Army training and materiel testing mission requirements.
c. Actively engage local communities in land use planning in areas subject to high levels of operational noise and a high potential for noise complaints.

14-4. Program Requirements.
a. Noise descriptors (metrics) appropriate for determination of compatible land use, and assessment procedures will be based on the best available scientific information.
(1) The day-night level (DNL) is the primary descriptor for military noise, except small arms, see Table 14-1. The DNL is the time weighted energy average sound level with a 10-decibel (dB) penalty added to the nighttime levels (2200 to 0700 hours). The DNL noise metric may be

further defined, as appropriate, by the installation with a specific, designated time period (e.g.,: annual average DNL, average busy month DNL).

The typical assessment period over which the noise energy is averaged is 250 days for Active Army installations and 104 days for Army Reserve and National Guard installations. The use of average busy month DNL is appropriate when the OPTEMPO is significantly different during certain peak periods of the year. For future land use planning and encroachment assessment purposes, a reasonable annual growth factor in activity (e.g., 10 or 15 percent) may be assumed.

(2) Supplemental metrics, such as single event noise data (e.g., Peak, PK 15(met) or CSEL), may be employed where appropriate to provide additional information on the effects of noise from test and training ranges. A-weighted maximum noise levels will be used to assess aviation low level military training routes (MTRs) and/or flight tracks.

(3) The use of average noise levels over a protracted time period generally does not adequately assess the probability of community noise complaints. Assess the risk of noise complaints from large caliber impulsive noise resulting from testing and training activities, ex. armor, artillery, mortars and demolition activities, in terms of a single event metric, either peak sound pressure level [PK 15(met)] or c-weighted sound exposure level (CSEL). The metric Pk 15(met) accounts for statistical variation in received single

event peak noise level that is due to weather. It is the calculated peak noise level, without frequency weighting, expected to be exceeded by 15 percent of all events that might occur. If there are multiple weapon types fired from one location, or multiple firing locations, the single event level used should be the loudest level that occurs at each receiver location.

(4) Assess noise from small arms ranges using a single event metric, either Pk 15(met) or a-weighted sound exposure level (ASEL).

(5) Use the land use planning zone (LUPZ) contour to better predict noise impacts when levels of operations at airfields or large caliber weapons ranges are above average.

(6) Use available DOD noise assessment software as the primary means of operational noise assessment.

(7) Prepare noise maps showing noise zones and limits as defined in Tables 14-1 and 14-2.

(8) Manage noise-sensitive land uses, such as housing, schools, and medical facilities as being acceptable within the LUPZ and noise zone I, normally not recommended in noise zone II, and not recommended in noise zone III. These noise zones are defined in Table 14-1.

(9) Single event noise limits in Table 14-2 correspond to areas of low to high risk of noise complaints from large caliber weapons and weapons systems. These should be used to supplement the noise zones defined in Table 14-1 for land use decisions. Noise sensitive land uses are discouraged in areas where PK 15(met) is between 115 and 130 dB; medium risk of complaints. Noise sensitive land uses are strongly discouraged in areas equal to or greater than PK 15(met) = 130 dB; high risk of noise complaints. For infrequent noise events, installations should determine if land use compatibility within these areas is necessary for mission protection. In the case of infrequent noise events, such as the detonation of explosives, the installation should communicate with the public.

(10) Transportation and industrial noise will be assessed on a case by case basis using appropriate noise metrics, including U.S. Department of Transportation guidelines.

b. Address issues concerning building vibration and rattle due to weapons blast through the appropriate subject matter experts and legal counsel.

c. Address noise impacts on domestic animals and wildlife, as required, through the study of each species' response or a surrogate response to noise. The noise levels set forth herein apply to humans only and do not apply to domestic animals or wildlife.

Table 14-1
Noise Limits for Noise Zones

Noise Zone	Noise Limits		
	Aviation ADNL	Impulsive CDNL	Small Arms PK 15(met)
LUPZ	60 – 65	57 – 62	N/A
I	< 65	< 62	< 87
II	65 – 75	62 - 70	87 – 104
III	> 75	> 70	> 104

Legend
dB = decibel
LUPZ = land use planning zone
ADNL = a-weighted day-night levels
CDNL = c-weighted day-night levels
PK 15(met) = Single event peak level exceeded by 15 percent of events
< = less than
> = greater than
N/A = Not Applicable

Table 14-2
Risk of Noise Complaints by Level of Noise

Risk of Noise Complaints	Large Caliber Weapons Noise Limits PK 15(met)
Low	< 115
Medium	115 – 130
High	130 – 140
Risk of physiological damage to unprotected human ears and structural damage claims	> 140

Legend
dB = decibel
PK 15(met) = Single event peak level exceeded by 15 percent of events
Notes:
1. Although local conditions regarding the need for housing may require noise-sensitive land uses in Noise Zone II, on or off post, this type of land use is strongly discouraged. 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 noise-sensitive land use would not be met if development were prohibited in Noise Zone II.

2. Where the community determines that these uses must be allowed, measures to achieve an outdoor to indoor noise level reduction (NLR) of at least 25 dB to 30 dB in Noise Zone II, from small arms and aviation noise, should be incorporated into building codes and be in individual approvals. The NLR for communities subject to large caliber weapons and weapons system noise is lacking scientific studies to accomplish the recommended NLR. For this reason it is strongly discouraged that noise-sensitive land uses be allowed in Noise Zone II from large caliber weapons.

3. Normal permanent construction can be expected to provide a NLR of 20 dB, for aircraft and small arms, thus the reduction requirements are often stated as 5, 10 or 15 dB over standard construction and normally assume mechanical ventilation, upgraded Sound Transmission Class (STC) ratings in windows and doors and closed windows year round. Additional consideration should be given to modifying NLR levels based on peak noise levels or vibrations.

4. NLR criteria will not eliminate outdoor noise problems. However, building location and site planning, and design and use of berms and barriers, can help mitigate outdoor noise exposure NLR particularly from ground level aircraft sources. Barriers are generally not effective in noise reduction for large arms such as artillery and armor, large explosions, or from high-level aircraft sources.

F.2 DEPARTMENT OF DEFENSE INSTRUCTION ON NOISE PROGRAMS

Department of Defense
INSTRUCTION

NUMBER 4715.13
November 15, 2005

USD(AT&L)

SUBJECT: DoD Noise Program

References: (a) DoD Directive 5134.1, "Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L))," December 9, 2005
(b) DoD Directive 5124.2, "Under Secretary of Defense for Personnel and Readiness (USD(P&R))," October 31, 1994
(c) DoD Instruction 4165.57, "Air Installations Compatible Use Zones," November 8, 1977
(d) DoD Directive 5000.1, "The Defense Acquisition System," May 12, 2003
(e) through (g), see enclosure 1

1. PURPOSE

Under the authority of reference (a) and in conformance with reference (b), this Instruction establishes policy and assigns responsibilities for a coordinated DoD noise program. It also provides for establishment of a DoD Noise Working Group (DNWG).

2. APPLICABILITY

This Instruction applies to the Office of the Secretary of Defense, the Military Departments, the Chairman of the Joint Chiefs of Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities within the Department of Defense (hereafter referred to collectively as the "DoD Components").

3. DEFINITION

Noise. For the purposes of this Instruction, noise is defined as unwanted sound generated from the operation of military weapons or weapons systems (e.g., aircraft, small arms, tank guns, artillery, missiles, bombs, rockets, mortars, and explosives) that affects either people, animals (domestic or wild), or structures on or in areas in proximity of a military installation;

1

occupational noise exposure and underwater sound associated with ship testing and training activities are specifically excluded from this definition.

4. POLICY

The DoD noise program shall:

4.1. Reduce adverse effects from the noise associated with military test and training operations consistent with maintaining military readiness.

4.2. Consider the adverse effects of noise from military weapons or weapons systems on the ability to test, train, and operate weapons systems during the development of Initial Capabilities Documents, Capability Development Documents, Capability Production Documents and Capstone Requirements Documents and throughout the Joint Capabilities Integration and Development System and associated acquisition processes.

4.3. Integrate, without degrading mission capabilities, noise management techniques and principles into installation, operational range, and operating area plans and programs and incorporate into Air Installation Compatible Use Zone and Joint Land Use Study program efforts (reference (c) and DoD Instruction 3030.3 (reference (g)).

4.4. Promote scientific research and the use of sound scientific methods and validated noise data as the basis for and the establishment of noise program guidance.

4.5. Promote the development of initiatives to educate and train DoD military, civilian and contractor personnel, and the public on noise issues.

4.6. Leverage resources to the maximum extent possible by ensuring the coordination of DoD noise program initiatives among the Department of Defense and other Federal Agencies.

4.7. Promote outreach with entities affected by noise generated from the operation of military weapons and weapons systems.

5. RESPONSIBILITIES

5.1. The Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) shall:

5.1.1. Provide policy, guidance, oversight, and representation for the DoD noise program.

5.1.2. Establish noise policy and guidance that fully addresses military readiness considerations and ensures noise impacts are considered in the development, acquisition, and fielding of weapons and weapons systems, in coordination with the Under Secretary of Defense for Personnel and Readiness and the Director of Operational Test and Evaluation.

5.1.3. Review USD(AT&L) DoD Directives 4165.57 and 5000.1 (references (c) and (d)) and DoD Instruction 4715.9 (reference (e)), and supporting references for consistency, revision, and elimination of duplicative requirements.

5.2. The Deputy Under Secretary of Defense for Installations and Environment (DUSD(I&E)), under the USD(AT&L), shall:

5.2.1. Develop and promulgate goals and objectives for the DoD noise program and establish metrics to evaluate progress toward meeting those goals and objectives.

5.2.2. Develop DoD noise program guidance and establish requirements and priorities for use in DoD Component planning, programming, and budgeting, in consultation with the DoD Components.

5.2.3. Consult with the Military Departments on their various installation compatible land use and noise management programs through the DNWG and the Range Sustainment Working Integrated Product Team process.

5.2.4. Establish, support, and provide guidance to a DNWG that includes representatives from the Military Departments. The DNWG shall:

5.2.4.1. Evaluate and advise the DUSD(I&E) and the DoD Components on noise-related issues that have a bearing on the Department of Defense's ability to carry out its assigned mission requirements.

5.2.4.2. Coordinate and provide recommendations on technical and policy issues concerning noise associated with military testing and training activities and the impacts of such noise.

5.2.4.3. Represent DUSD(I&E) at meetings of the Federal Interagency Committee on Aviation Noise and maintain liaison with other Federal and State Agencies, nongovernmental organizations, professional organizations, educational institutions, and industries having similar interests or responsibilities.

5.3 The Under Secretary of Defense for Personnel and Readiness shall:

5.3.1. Coordinate on all policy and guidance issued by the USD(AT&L) regarding the DoD noise program to ensure the policy and guidance fully address military readiness considerations.

5.3.2. Review DoD Directive 3200.15 (reference (f)) and supporting issuances for consistency, revision, and elimination of duplicative requirements.

5.4 The Director of Operational Test and Evaluation shall coordinate on all policy and guidance issued by USD(AT&L) regarding the DoD noise program to ensure the policy and guidance fully consider impacts on testing and evaluation and the operations of the Major Range and Test Facility Base within the Department.

5.5. The Heads of the DoD Components shall:

5.5.1. Provide management support, resources, and professionally qualified staff sufficient to ensure effective implementation of the DoD noise program at all organizational levels.

5.5.2. Provide representatives to the DNWG.

5.5.3. Analyze current and future test and training needs to support effective planning, programming, budgeting, and execution of DoD noise program requirements.

5.6. The Chairman of the Joint Chiefs of Staff shall ensure the impacts of noise emissions on the ability to train and operate are considered during the Joint Capabilities Integration and Development System process.

6. EFFECTIVE DATE

This Instruction is effective immediately.

NOV 1 5 2005

Kenneth J. Krieg
Under Secretary of Defense
For Acquisition, Technology, and Logistics

Enclosures - 1
E1. References, continued

Appendix G
Sample Documents

G.1 SAMPLE NOISE DISCLOSURE AND WAIVER

SAMPLE NOISE DISCLOSURE AND WAIVER

Parcel ____________________ County ____________________

Grantor(s) Name ____

____

Grantor(s) Address ______________________________________

____

LEGAL DESCRIPTION:

In accordance with section ________ of the Land Use Ordinance for ________ County, State of __________, furnish disclosure to the owners and potential owners of the above described property adjacent as follows:

1. The Grantors, their heirs, successors, and assigns acknowledge this disclosure that the described property is situated in an area that may be subjected to conditions resulting from military training at __________________. Such conditions include the firing of small and large caliber weapons, the overflight of both fixed-wing and rotary-wing aircraft, the movement of vehicles, the use of generators, and other accepted and customary military training activities. These activities ordinarily and necessarily produce noise, dust, smoke and other conditions that may conflict with Grantors' use of Grantors' property for residential and other purposes, and Grantors hereby acknowledge the existence of ____________________ activities.

2. Nothing in this disclosure shall grant a right to ____________________ for ingress or egress upon or across the described property. Nothing in this disclosure shall prohibit or otherwise restrict the Grantors from enforcing or seeking enforcement of statues of regulations of governmental agencies for activities conducted on adjacent properties.

3. This disclosure is appurtenant to all property adjacent to the above described property and shall bind to the heirs, successors, and assigns of Grantors and shall endure for the benefit of the adjoined __________________. ____________________ is hereby expressly granted the right of third party enforcement of the disclosure.

IN WITNESS WHEREOF, the Grantors have executed this disclosure dated this _____ day of _______________, 20_____.

____
Grantor

____
Grantor

G.2 SAMPLE NOISE EASEMENT

SAMPLE NOISE EASEMENT

Parcel ___________________ County ___________________

Grantor(s) Name _____________________________________

____

Grantor(s) Address ___________________________________

____

LEGAL DESCRIPTION:

In accordance with section ________ of the Land Use Ordinance for ________ County, State of __________, approving a permit for residential development on the above described property, and in consideration do such approval, Grantors grant to the owners of all property adjacent to the above described property, a perpetual nonexclusive easement as follows:

1. The Grantors, their heirs, successors, and assigns acknowledge by the granting of this easement that the residential development is situated in an area that may be subjected to conditions resulting from military training at ___________________. Such conditions include the firing of small and large caliber weapons, the overflight of both fixed-wing and rotary-wing aircraft, the movement of vehicles, the use of generators, and other accepted and customary military training activities. These activities ordinarily and necessarily produce noise, dust, smoke, and other conditions that may conflict with Grantor's use of Grantor's property for residential purposes. Grantors hereby waive all common law rights to object to normal and necessary military training activities legally conducted on adjacent ___________________ which may conflict with Grantor's use of Grantor's property for residential and other purposes, and Grantors hereby grant an easement to the adjacent ___________________ for such activities.

2. Nothing in this easement shall grant a right to ___________________ for ingress or egress upon or across the described property. Nothing in this easement shall prohibit or otherwise restrict the Grantors from enforcing or seeking enforcement of statues of regulations of governmental agencies for activities conducted on adjacent properties.

3. This easement is appurtenant to all property adjacent to the above described property and shall bind to the heirs, successors, and assigns of Grantors and shall endure for the benefit of the adjoined _________________. ___________________ is hereby expressly granted the right of third party enforcement of the easement.

IN WITNESS WHEREOF, the Grantors have executed this easement dated this _____ day of ______________, 20_____.

____
Grantor

____
Grantor

Appendix H
Glossary of Terms, Acronyms, and Abbreviations

H.1 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.

Community – those individuals, organizations, or special interest groups affected by or interested in decisions affecting towns, cities, or unincorporated areas near or adjoining a military installation, and officials of local, state, and Federal governments, and Native American tribal councils responsible for the decision making and administration of programs affecting those communities.

Community Involvement Program – a carefully designed program that uses a variety of techniques to inform the public of possible decisions and their potential consequences, and provides opportunities for consultation with the public so that their views may be considered before any decisions are made.

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. This average is calculated over a "year," or about 250 training days.

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

Encroachment – use or development of the land around a military installation that is incompatible with the operations of that installation.

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

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

Modularity – the military concept where forces are constructed of highly skilled and relatively standardized units (in training and equipment) in order to maintain the greatest possible combat flexibility and the shortest possible deployment times.

Noise – any sound without value.

Noise Exposure – the cumulative acoustic stimulation reaching the ear of a person over a specified period of time (e.g., a work shift, a day, of a lifetime).

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 if the designated room in the building.

Noise Zone III (NZ III) – the area around a noise source in which the C-weighted day-night sound level (CDNL) is greater than 70 dB, the A-weighted day-night level (ADNL) is greater than 75 dB, or the PK15(met) is greater than 104 dB. The noise level within NZ III is considered so severe that noise sensitive activities should not be conducted therein.

Noise Zone II (NZ II) – the area around a noise source in which the C-weighted day-night level (CDNL) is 62-70 dB, the A-weighted day-night level (ADNL) is 65-75 dB, or the PK15(met) is 87-104 dB. The noise level within NZ II is considered significant and use of this land should normally be limited to activities such as industrial, manufacturing, transportation, and resource production.

Noise Zone I (NZ I) – included all areas around a noise source in which the C-weighted day-night sound level (CDNL) is less than 62 dB, the A-weighted day-night level (ADNL) is less than 65 dB, or the PK15(met) is less than 87 dB. This area is usually suited for all types of land use activities.

PK15(Met) – peak sound level, without frequency weighting and accounting for the statistical variation cause by weather, expected to be exceeded by 15 percent of all events that might occur. A PK15(met) level of greater than 130 dB has a high risk of complaints, 115-130 dB has a moderate risk of complaints, and below 115 dB has a low risk of complaints.

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

Small Arms – conventional military weapons less than 20 millimeters 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.

Sound Level Meter – an instrument consisting of an amplifier, microphone, and a graduated readout that provides a direct reading of the sound pressure level at a particular location. Sound may be measured in a variety of metrics (e.g., ADNL, CDNL, PK(15)met, etc.) and they must satisfy the requirements of the American National Standards Institute (ANSI) Standard for Sound Level Meters (S1.4-1983).

Standard Land Use Coding Manual (SLUCM) – standard system for identifying and coding land use activities. Published by the U.S. Department of Commerce, 1965.

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.

H.2 GLOSSARY OF ACRONYMS AND ABBREVIATIONS

A

AAF	Army Airfield
ADNL	A-Weighted Day-Night Average Sound Level
ANSI	American National Standards Institute
AR	Army Regulation
ARNG	Army National Guard

B

BN	Battalion

C

CDNL	C-Weighted Day-Night Average Sound Level
CHABA	National Academy of Sciences Committee on Hearing, Bioacoustics, and Biomechanics
CIP	Capital Improvement Program

D

DA	Department of the Army
dB	Decibel(s)
dBA	Decibels, A-Weighted
dBC	Decibels, C-Weighted
dBP	Decibels, Unweighted Peak
DNL	Day-Night Average Sound Level
DOD	Department of Defense
DODI	Department of Defense Instruction

E

EA	Environmental Assessment
EDA	Economically Distressed Area
EIS	Environmental Impact Statement
EJ	Environmental Justice
ENMP	Environmental Noise Management Plan
EOD	Explosive Ordinance Disposal
EPA	Environmental Protection Agency

F

FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FUCUN	Federal Interagency Committee on Urban Noise
FORSCOM	U.S. Army Forces Command
FY	Fiscal Year

G

GIS	Geographic Information System

H

HQ	Headquarters
HQDA	Headquarters, Department of the Army
HR	U.S. House of Representatives
HUD	U.S. Department of Housing and Urban Development
Hz	Hertz

I

ICUZ	Installation Compatible Use Zone
IG	Inspector General
IONMP	Installation Operational Noise Management Plan

J

JLUS	Joint Land Use Study

K

None

L

LEQ	Equivalent Sound Level

M

MOA	Military Operations Area
MP	Military Police
MSL	Mean Sea Level

N

NAS	Navel Air Station
NE	Northeast
NEPA	National Environmental Policy Act
NFS	National Forest Service
NGB	National Guard Bureau
NLR	Noise Level Reduction
NOE	Nap of the Earth
NW	Northwest
NZ	Noise Zone
NZ I	Noise Zone I
NZ II	Noise Zone II
NZ III	Noise Zone III

O

OMB	Office of Management and Budget
ONMP	Operational Noise Management Program

P

PAO	Public Affairs Office
PL	Public Law

Q

None

R

R&D	Research and Development
RC	Reserve Components
ROTC	Reserve Officer's Training Corps
RW	Rotary-wing Aircraft (i.e., a helicopter)

S

SCS	Soil Conservation Service (US)
SE	Southeast
SEL	Sound Exposure Level
SGS	Secretary of the General Staff
SJA	Staff Judge Advocate
SLUCM	Standard Land Use Coding Manual
SONMP	Statewide Operational Noise Management Plan
STC	Sound Transmission Class
SW	Southwest

T

TDR	Transfer of Development Rights
TM	Technical Manual
TRADOC	U.S. Army Training and Doctrine Command

U

USACERL	U.S. Army Construction Engineering Research Laboratories
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAF	U.S. Air Force
USAR	U.S. Army Reserve
USC	U.S. Code
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service

V

VA	U.S. Department of Veterans Affairs
VMC	Visual Meteorological Conditions

W, X, Y, Z

None

Appendix I

References, Sources, and Related Reading

AEPI, 1999, Publication #0110, Army Operational Noise Management Program Review**.**

ANSI, 1983, S1.4-1983, American National Standard Specifications for Sound Level Meters.

ANSI, 1986, S12.4-1986, American National Standard Method for Assessment of High-Energy Impulsive Sounds with Respect to Residential Communities.

Bureau of Mines, 1980, Report No. RI 8507, Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting.

CHABA, 1981, Committee on Hearing, Bioacoustics, and Biomechanics Working Group 84 Report, Assessment of Community Response to High-Energy Impulsive Sounds.

City of Sparta, 2007. Homepage URL- http://www.spartawisconsin.org

City of Tomah, 2007. Homepage URL- http://www.tomahwisconsin.com

Cumerlato, 1994, C.L. Cumerlato and D.E. Siskind, "Residential Structural Responses to Airblast from Munitions Disposal at the McAlester Army Ammunition Plant," Proceedings, Tenth Annual Symposium on Explosives and Blasting Research.

DODI, 1977, Department if Defense Instruction 4165.57, Air Installation Compatible Use Zones.

DODI, 1983, Department of Defense Instruction 3030.2, Community Planning and Impact Assistance.

FAA, 1976, Report No. FAA-RD-76-87, Statistical Model of Sonic Boom Structural Damage.

FAA, 1990, Day Night Average Sound Level (DNL), The Descriptor of Choice for Airport Noise Assessment.

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

Helicopter Association International (HAI), 1983, I Fly Neighborly.

Lewis, 1994, "Prediction of Impulsive Noise Levels: A Different Approach," presented at the 127th Meeting of the Acoustical Society of America, Cambridge, Massachusetts.

Luz, G.A. and N.D. Lewis, 1979, "Problems in Using the C-Weighted Day-Night Level to Assess Military Blast Noise Environments," Presented at the 97th Meeting of the Acoustical Society of America, Cambridge, Massachusetts.

Luz, 1985, "A Statistical Model for Predicting the Probability of Complaints from Army Weapon Noise," Presented at the 110th Meeting of the Acoustical Society of America, Nashville, Tennessee.

Monroe County, 2007. Homepage URL- http://www.wisconline.com/counties/monroe

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

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

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

Raspet and Lewis, 1986, "Reduction if Artillery Noise by Natural Barriers," Journal of Applied Acoustics, Volume 19, Number 2, pages, 117-130.

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.

Schomer, P.D., 1994, "New Descriptor for High-Energy Impulsive Sounds," Noise Control Engineering Journal.

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

State of Wisconsin, 2006, Department of Workforce Development, Office of Economic Advisors, Monroe County Workforce Profile.

U.S. Air Force, 1977, AARML Report No. ARML-TR-73-110, Community Noise Exposure Resulting from Aircraft Operations, Volume 2, Acoustic Data on Military Aircraft: Air Force Bomber/Cargo Aircraft.

U.S. Air Force, 1978, AARML Report No. ARML-TR-73-110, Community Noise Exposure Resulting from Aircraft operations, Volume 3, Acoustic Data on Military Aircraft: Air Force Attack/Fighter Aircraft.

U.S. Air Force, 1988, Report No. AARML-TR-88-060, ROUTEMAP Model for Predicting Noise Exposure from Aircraft Operations on Military Training Routes.

U.S. Air Force, 1990a, Report No. AARML-TR-90-011, Air Force Procedure for Predicting Aircraft Noise around Airbases: Noise Exposure Model (NOISEMAP) User's Manual.

U.S. Air Force, 1990b, Report No. AARML-TR-90-012, Air Force Procedure for Predicting Aircraft Noise around Airbases: Airbase Operations Program (BASEOPS) Description.

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

U.S. Army, 1978, Technical Manual 5-803-2, Planning in the Noise Environment.

U.S. Army, 1978, Technical Manual 5-803-4, Planning of Army Aviation Facilities.
U.S. Army, 1984, Construction Engineering Research Laboratory Technical Report N-167, Community Reaction to Impulsive Noise: A 10 Year Research Summary.

U.S. Army, 1986, Construction Engineering Research Laboratory Technical Report N-86/12, MicroBNOISE: A Users Manual.

U.S. Army, 1987a, Construction Engineering Research Laboratory Technical Report N-87/24, Expedient Methods for Tattle-Proofing Certain Housing Components.

U.S. Army, 1988a, Construction Engineering Research Laboratory Technical Report N-88/19, Procedures for Conducting Installation Compatible Use Zone (ICUZ) Studies.

U.S. Army, 1988b, Construction Engineering Research Laboratory Technical Report N-88/07, Procedures for Estimating the Flat-Weighted Peak Level Produced by Surface and Buried Charges.

U.S. Army, 1988c, Army Regulation 95-2, Air Traffic Control, Airspace, Airfields, Flight Activities and Navigational Aids.

U.S. Army, 1988d, USAEHA Environmental Noise Assessment No. 52-34-0413-89, Results of Demolition Range Monitoring, Sierra Army Depot, Herlong, California, 12–20 September 1988.

U.S. Army, 1989, USAEHA Environmental Noise Study No. 51-34-0421-90, Results of Demolition Range Monitoring, Sierra Army Depot, Herlong, California, 31 July – 10 August 1989.

U.S. Army, 1991, USEHA Environmental Noise Consultation No. 52-34-0652-91, Noise Contours and Monitoring Results, Picatinny Arsenal, Dover, New Jersey, 26 November – 20 December 1990.

U.S. Army, 1992, USAEHA Environmental Noise Survey No. 52-34-Q492-92, Results of Impulsive Noise Monitoring, Navajo Depot Activity, Bellemont, Arizona, 15 May – 13 November 1991.

U.S. Army, 1994, Center for Health Promotion and Preventive Medicine Environmental Noise Study No. 52-34-QK33-95, Results of Eastern Shore Vibration Monitoring, Aberdeen Proving Ground, Maryland, September 1993 – November 1994.

U.S. Army, 1994, Fort Knox Joint Land Use Study.

U.S. Army, 1996, Center for Public Works, The DPW/DEH Reference Book.

U.S. Army, 1997, Army Regulation 200-1, Environmental Protection and Enhancement.

U.S. Army, 2001, Technical Manual 5-803-7, Airfield and Heliport Planning and Design.

U.S. Army, 2004, Army Training Circular, No. 25-8, Training Ranges, FCC 17809 Qualification Training Range (QTR).

U.S. Army, 2004, Fort McCoy Regulation 350-2, Training.

U.S. Army, 2005, Department of the Army Pamphlet 40-11, Preventive Medicine.

U.S. Army, 2006, Fort McCoy Directorate of Plans, Training, Mobilization and Security, Biological and Cultural Resources Team, Record of Environmental Consideration, Convoy Live Fire Range, Range 4.

U.S. Army, 2006, Fort McCoy Directorate of Plans, Training, Mobilization and Security, Biological and Cultural Resources Team, Record of Environmental Consideration, Range 105 25 Meter Zero Range

U.S. Army, 2006, Fort McCoy Public Affairs Fact Sheet, Fort McCoy's Economic Impact.

U.S. Army, 2007, Installation Management Agency, Draft Environmental Assessment, 32 CFR Part 651.32, Construction of a Combined Arms Collective Training Facility (CACTF) at Fort McCoy, Wisconsin.

U.S. Army, 2007, Fort McCoy Sustainable Range Program, Range Development Plan.

U.S. Census Bureau, 2007. Homepage. URL- http://www.census.gov

U.S. Department of Labor, 2007. Homepage.URL- http://www.stats.bls.gov