

SOUND STUDY REPORT

PROPOSED SHOOTING RANGE
BURKE COUNTY, NORTH CAROLINA

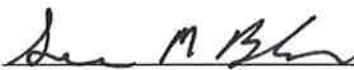
Prepared for:
North Carolina Wildlife Resources Commission
Division of Engineering and Land Management
Creedmoor, North Carolina

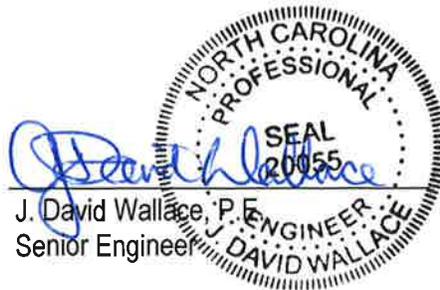
By:



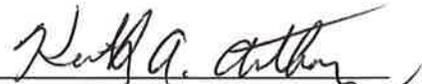
4301 Taggart Creek Road
Charlotte, North Carolina

Shield Project No. 1130132-01


Sean M. Brickner, E.I.T.
Staff Engineer



J. David Wallace, P.E.
Senior Engineer


Keith A. Anthony, P.E.
Chief Engineer

October 8, 2013

TABLE OF CONTENTS

	<u>Page</u>
Project Background.....	1
Shooting Sessions	1
Sound Monitoring	2
Sound Data.....	3
Interpretation of Sound Data.....	4
Conclusions.....	6

FIGURES

Figure 1	Proposed Shooting Range #1 and Sound Measuring Location Map
Figure 2	Proposed Shooting Range #2 and Sound Measuring Location Map
Figure 3	Lpeak Sound Levels
Figure 4	Lpeak Sound Levels at Location #1
Figure 5	Lpeak Sound Levels at Location #2
Figure 6	Lpeak Sound Levels at Location #3

TABLES

Table 1	Maximum (Lpeak) Sound Level (Decibels) at Measuring Locations by Weapon
Table 2	Average (Lpeak) Sound Level (Decibels) at Measuring Locations by Weapon
Table 3	Typical Sound Levels (Decibels) for Common Sound Sources

APPENDICES

Appendix A	Site Photographs
------------	------------------

Project Background

A shooting range is proposed at one of the two possible sites alongside State Road 126 southeast of Linville, NC in Burke County (see **Figures 1 and 2**). The two proposed shooting range sites are approximately 1000 feet apart. The primary purpose for this sound study is to collect sound data in the area of these two shooting range sites in order to understand the levels of sound emanating from each of the proposed shooting range sites. Sound monitors were located in the general vicinity of nearby residents in order to measure sound levels if a shooting range should eventually be constructed at one of these two sites. The sound data presented in this study will also be available to assist in the design of the proposed shooting range at either one of these two sites. The purpose of this letter report is to summarize the sound study and the subsequent findings of said study.

Shooting Sessions

The sound study was conducted on August 14, 2013. In order to conduct the sound study, representatives from N.C. Wildlife Resource Commission (NCWRC) and Shield Engineering, Inc. (Shield) agreed to conduct a shooting session alongside State Road 126 near the proposed shooting range (Site #1, Elevation – 1233 feet above National Geodetic Vertical Datum [NGVD]) and then a subsequent shooting session alongside Wolf Pit Road (Site #2, Elevation – 1258 feet above NGVD). Each of these shooting sessions was conducted in a manner similar to a typical practice shooting session which could be expected at a typical shooting range.

The NCWRC Law Enforcement Officers assigned to perform the shooting for this sound study, used several different types of weapons. These weapons are as follows:

1. Pistol SIG SAUER P226 (.357 SIG)
2. Shotgun Remington 870 (12 gauge)
3. Rifle Thompson Center Venture (.270 Caliber)
4. Rifle AR-15 Bushmaster (.223 Caliber)
5. Rifle Savage Model 788 (7 mm Caliber)
6. Rifle Remington Model 788 (.243 Caliber)

Hence each of the two shooting sessions consisted of, in order; pistols, shotguns, and rifles. At a typical shooting range, several shooters could be firing weapons at the same time. Thus, for the execution of the sound study a total of four (4) officers from NCWRC Division of Law Enforcement were made available for the two shooting sessions. The scenario for each of the two shooting sessions was conducted in the manner described in the next paragraph.

The pistols were the first weapons to be discharged by the officers. The officers discharged a total of 96 rounds of ammunition. The pistols were discharged sporadically by all four officers throughout the time frame. Next the shotguns were discharged by the officers, 5 shells by each officer at a rate of one shell per second. A total of 20 shotgun shells were discharged. As with the pistols, the shotguns were also discharged sporadically throughout the time frame. During the shooting session several officers shot their weapons (pistols and shotguns) at the same time. The rifles were discharged last by the officers; each officer discharged 5 rounds at an

approximate rate of one round per second. A total of 20 rounds of ammunition were discharged within a period of 3 minutes. Unlike the pistols and shotguns the rifles were discharged in sequence one officer after another with each officer firing 5 rounds of their selected weapons. The rifles were discharged in the following sequence; 1) Thompson Center Venture; 2) Savage Model 788; 3) Remington Model 788; and 4) AR-15 Bushmaster.

The same shooting scenario was conducted at each of the two possible shooting range sites.

Sound Monitoring

For monitoring the sound levels three (3) Quest Technologies SoundPro DL-1 Type 2 impulse sound level meters were used to record sound levels before, during, and after each of the two shooting sessions described above. These sound level meters are capable of recording sound levels up to 140 decibels (dB). All three sound level meters were set to record impulse sound set on A-weighted (dBA) sound level readings, which matches human hearing. The sound level meters were calibrated prior to the recording of sound levels at the three monitoring sites identified below. A windscreen was installed on the tip of the microphone of each sound level meter to reduce sound disturbances caused by physical contact and wind turbulence.

NCWRC personnel and a representative from Shield were the sound level meter operators. The NCWRC personnel selected for the sound study were informed of their duties prior to operating the data logging equipment. Each of these three (3) individuals was assigned a number from 1 to 3 and a corresponding location as shown on **Figures 1** and **2**. The nearest addresses of the adjacent property at each of these locations are as follows:

- Location #1 - 5539L1 Linville Shores Drive, Pisgah National Forest, Nebo, NC 28761 (Elevation – 1203 feet above NGVD)
- Location #2 - 5443 NC 1, Morganton, NC 28655 (Elevation – 1339 feet above NGVD)
- Location #3 - 1046 Overlook Cove Road, Morganton, NC 28655 (Elevation – 1255 feet above NGVD)

Each operator set up the sound level meter on a tripod and located the sound level meters so that it would be in a relatively open area free of reflective surfaces. Photographs of the sound level meter and tripod at each location are shown on the attached Photograph Nos. 1 through 6 in **Appendix A**. Each sound level meter operator had a two-way radio for communication with the shooting range in order to check for readiness of each sound level meter. For the period of time during which each sound meter was recording sound, the operator kept a log of noises heard and the time at which each noise was heard, or for long-lasting noises (e.g., mower, chainsaw, ATV, etc.) the duration of time over which the noise was heard at that location.

Sound meter Location #1 was located approximately 0.85 miles from the shooting range Site #1 and nearly 1.0 mile from shooting range Site #2. Sound meter Location #2 was located approximately 0.85 miles from the shooting range Site #1 and approximately 0.83 miles from shooting range Site #2. The final sound meter Location #3 was located approximately 2.3 miles from the shooting range Site #1 and approximately 2.45 miles from shooting range Site #2.

The sound meters were setup and started prior to the commencement of the shooting in order to accumulate background sound data for each of these monitoring locations. The starting times for each sound level meters varied and were as follows:

- Location #1 - 10:41:35 August 14, 2013
- Location #2 - 11:01:19 August 14, 2013
- Location #3 - 10:40:42 August 14, 2013

The sound study was conducted on a clear and sunny day with the absent of any rain, fog, or any other weather feature that could have impeded sound waves traveling through the air.

Sound Data

The sound level meters were set to record sound levels at one-second intervals for the period of time the sound level meter was turned on. During each of these 1-second intervals the following sound level readings were recorded by each sound level meter:

- Lpeak - highest impulse sound pressure level in decibels (Note: sound level meters were set on impulse mode) obtained during the preset 1-second recording interval for the sound level meter (Note: sound was assessed for each 35-microsecond interval during each 1-second recording interval to determine the peak);
- Lavg - average sound pressure level in decibels for each recording interval of 1 second; and
- Lmax – root mean square (rms) of maximum sound pressure levels in decibels during each recording interval of 1 second. The Lmax is usually less than the Lpeak.

Sound levels were recorded for periods of time before, during and after each shooting session and the intervening period of about 17 minutes between the two shooting sessions. The approximate times for each type of weapon for both shooting sessions were as follows:

Shooting Session (Proposed Shooting Site #1 – State Road 126)

1. Pistols: 11:17:00 am – 11:22:00 am
(PAUSE)
2. Shotguns: 11:25:00 am – 11:26:00 am
(PAUSE)
3. Rifles: 11:31:00 am – 11:34:00 am

Shooting Session (Proposed Shooting Site #2 – Wolf Pit Road)

1. Pistols: 11:51:00 am – 11:53:00 am
(PAUSE)
2. Shotguns: 11:57:00 am – 11:58:00 am
(PAUSE)
3. Rifles: 12:03:00 am – 12:06:00 am

The Lpeak sound level data are typically more representative of the sound impulse levels from weapons used at a shooting range. Typically the Lmax and Lavg sound levels are less than the Lpeak. The Lpeak sound level data are presented for review in two different forms.

The first form for presenting the Lpeak sound level data is in a tabular form – see **Tables 1** and **2**. **Table 1** presents the maximum Lpeak sound levels for various phases of the sound monitoring period. The top row in **Table 1** (shaded in tan color) shows the maximum Lpeak sound level, with the time at which that maximum was recorded, for the total period of measurement at each sound level meter measuring location. The last row in **Table 1** (shaded in tan color) shows the maximum Lpeak sound level, with the time at which that maximum was recorded at each sound level meter measuring location, for the period of measurement excluding the six shooting sessions during which weapons were being discharged. Between these two tan colored rows are two blocks of four rows each. Each four-row block summarizes data for each shooting range site. The first row in each four-row block provides the distance in miles from each shooting range to the sound meter locations labeled at the top of the columns. The remaining three rows in each four-row block provides the maximum Lpeak sound level recorded over the period of time during which different types of weapons were being discharged (type of weapon is identified in the first column), at the proposed shooting range site. **Table 2** is laid out in the same manner as **Table 1**. However, instead of exhibiting the maximum Lpeak sound data, **Table 2** shows the average of all the one-second Lpeak sound levels for each of the three sound meter locations. For example, if the period of time was for one minute, the average Lpeak sound level would be the average of the 60 one-second maximum Lpeak sound levels recorded by the sound level meter during that minute.

The second form for presenting the sound level data is in a series of graphs. The Lpeak sound level data for the total time period during which sound level meters were recording sound are shown for each of the three measuring locations on **Figure 3**. In order to better distinguish between the sound data recorded at each monitoring location, separate graphs for each sound measuring location are shown on **Figures 4** through **6**. For these three latter figures the timing of each of the shooting sessions are also shown on these figures.

Interpretation of Sound Data

Upon a review of **Table 1** two of the three sound level meter locations (Location #1 and #3) exhibited the highest Lpeak sound level during the time when no weapons were being discharged at either of the two shooting sites. Sound meter Location #2 was near State Road 126 and as a result of frequent traffic sound the Lpeak was much higher at this location compared to the others. Hence, the maximum Lpeak at Location #2 of 86.1 dBA was due to a vehicle passing by which was recorded during the shooting of the pistols at shooting range Site #1.

Overall the maximum Lpeak sound levels created by the shooting of the three different types of weapons at the two separate shooting sites (i.e., six periods of a minimum of one minute each) are indistinguishable from the overall peak sound levels recorded during the total period of record at each of the three sound level meter locations. A review of the combination of both the written logs from each sound measuring location and the sound data plots for the total period of record does indicate that other extraneous sounds occurred at each location (see **Figures 4**

through 6). In some instances these extraneous sounds masked the sound of the weapons from either of the two shooting sites (see **Figures 4 through 6**) or the extraneous sounds were either just as loud as, or louder, than the sound resulting from the weapon shooting at both shooting sites.

At Location #1 many factors such as boat traffic, children talking, birds chirping, ATV's, golf carts and cicadas near the sound meter contributed to the recorded sound levels (see **Figure 4**). This sound meter was located in a flat open area near the shore of Lake James. Location #1 was selected as a sound meter location because of its close proximity to nearby residential properties. A jet plane flying overhead at sound meter Location #1 at 11:58:49 registered an Lpeak of 80.5 dBA on the sound level meter. The recorded sound data at Location #1 exhibited a marked drop in the average sound data at about 11:46:00 am. The sound data typically ranged from 60 to 65 dBA before 11:46:00 am whereas after the data range was 57.5 to 62.5 dBA. The primary cause of this overall decline in sound data at Location #1 was due to the cessation of a lawnmower. Prior to 11:46:00 am this lawnmower had come to within 100 yards of Location #1 at about 11:20:00 am, which is noticeable in the rising sound levels at this time in **Figure 4**. Following the cessation of the lawnmower, it was restarted at approximately 12:20:00 am and came towards the sound meter, before turning off around 12:22:00 am.

At Location #2 heavy vehicular traffic from State Road 126 and Pea Ridge Road produced sound levels readings higher than the other sound meter locations (see **Table 1**). Additionally, the Lpeak sound data exhibited at this location more variability and a wider range of sound levels (see **Figure 5**). This specific location was on a flat open area surrounded by State Road 126 (south), Pea Ridge Road (east) and wooded area (north and west). Vehicle traffic at sound meter Location #2 at 11:17:30 registered a Lpeak of 86.1 dBA during the pistol shooting session at the proposed shooting range Site #1 (see **Figure 5**). In general when there was no vehicular traffic the sound levels ranged from 52.5 to 57.5 dBA.

At Location #3 sound from an occasional boat passing by on Lake James, planes flying overhead, birds chirping, and cicadas resulted in sound levels commensurate with the maximum Lpeak sound levels from the shooting of the three different types of weapons at the two separate shooting sites (see **Figure 5**). Additionally, a light wind rustling dead leaves nearby added to the background noise at this location. Therefore, sound levels were generally lower than the other two locations and tended to exhibit a generally narrow range of sound levels (see **Figure 6**). Location #3 did not record many notable sounds above 70.0 dBA. The maximum Lpeak reading of 79.0 dBA was produced by crackling of a 2-way radio from one of the sound meter operators' equipment.

The average Lpeak sound levels in **Table 2** are shown for the period of record on the top row and the average Lpeak sound levels for the period of record excluding the shooting sessions are shown on the bottom row of **Table 2**. Whenever the top row values in **Table 2** are higher than the bottom row values, then the implication is that the sound from the shooting of the weapons increased the sound levels at the respective location(s). However, the difference between these rows only range from 0.0 to 0.2 dBA. The average Lpeak sound levels during the two shooting sessions were higher than the average Lpeak sound levels for the period of record at Locations #2 (0.2 dBA) and #3 (0.1 dBA). However, this did not necessarily preclude the presence of

extraneous noises during these times, as discussed above. The average Lpeak sound levels at these two sites for each of the shooting sessions shown in **Table 2** range from 57.1 up to 70.0 dBA.

Sound level data in **Table 3** may be used to enable the reader to place the above sound levels in the context of commonly heard sound levels. Hence the sound levels recorded at the sound monitoring Locations #1 and #3 during the shooting sessions (see **Table 2**) are comparable to sound emanating from normal conversation. None of the average Lpeak sound levels at any of the measuring locations during the shooting sessions exhibited sound levels close to those that may be heard from residents using their lawn mowers or their power saws, or from jets flying overhead or normal traffic on SR 126.

Additionally, the maximum Lpeak sound levels heard at any of the measuring locations (except Location #2) as a result of weapon shooting barely attained the sound level range caused by typical cars passing at 50 mph (65 – 72 dBA: see **Table 3**). Sound at measuring Location #2 was predominantly from vehicular traffic passing the sound meter on SR 126. The main difference between typical cars passing by and weapons being discharged is that the former is a transient source of sound, whereas the latter is a series of sharp fluctuations in sound.

Conclusions

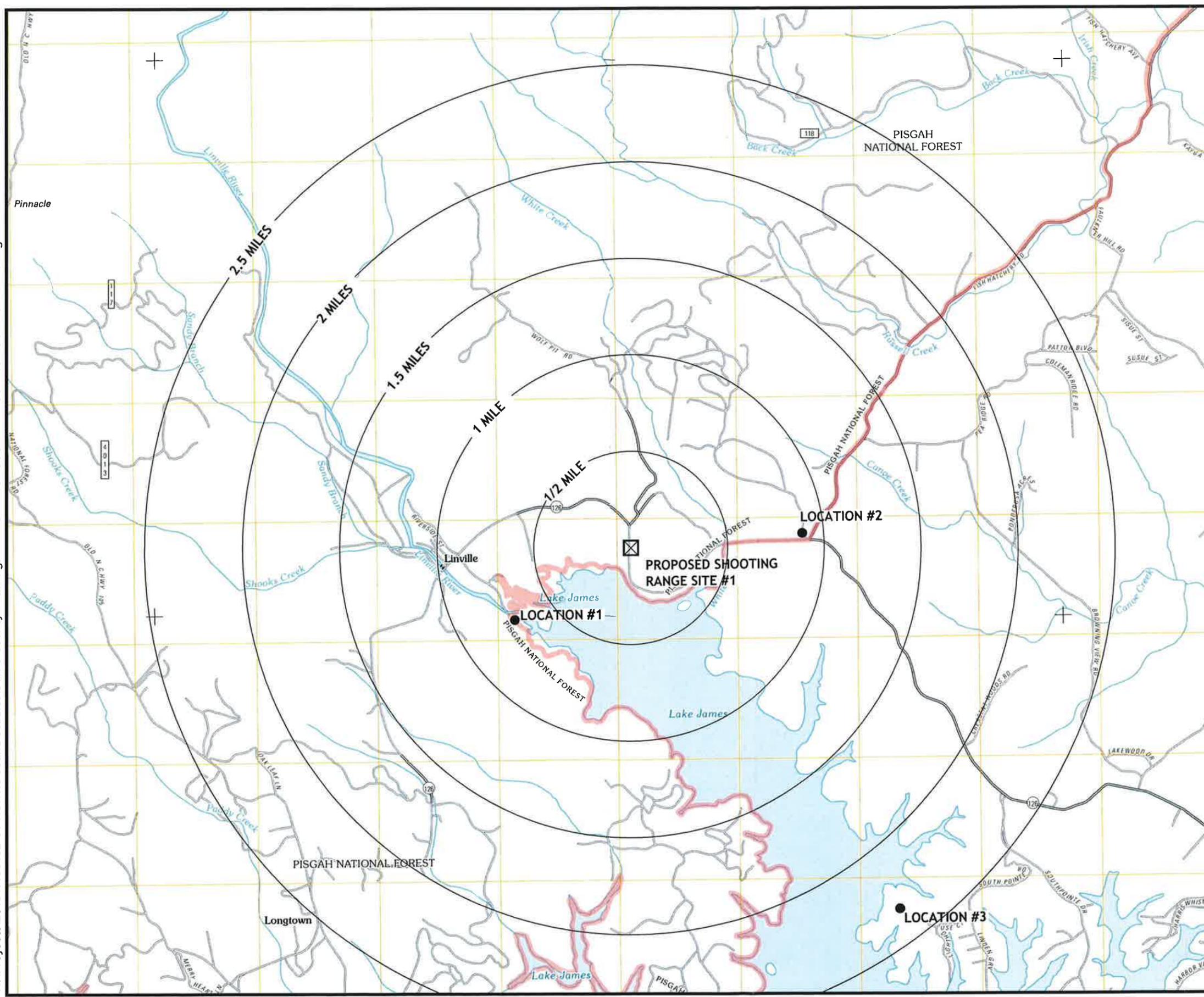
The following conclusions are summarized from the sound survey recently completed in the area southeast of Linville, NC alongside State Road 126 and Wolf Pit Road on August 14, 2013:

- Extraneous noise sources were evident at each of the measuring locations exhibiting sound level variations that did not match the timing for the weapons being discharged during each shooting session, as two of the three sound level meter locations (except Location #2 which was due to vehicle traffic) exhibited the highest Lpeak sound level at times when no weapons were being discharged at either of the two shooting range sites (see **Table 1**);
- The average Lpeak sound levels exhibited at each location for the period of time during each of the shooting sessions are all less than noise emanating from such typical household noises such as power mowers, chainsaws, and are generally within the range of normal conversation;
- No evidence of disturbing sound levels (i.e., sound levels exceeding the 90 to 95 dBA: see **Table 3**) was evident from the sound study conducted at the three sound measuring locations;
- The maximum Lpeak sound levels created by the weapon shooting at either shooting site are indistinguishable from other Lpeak sound levels recorded during the total period of record at each of the three sound level meter locations (see **Figures 4 through 6**). Plots of Lpeak sound data does indicate that other extraneous noises occurred at each measuring location, such as traffic, planes, boats, power mowers, ATVs, birds, etc.

- Both shooting range sites exhibited similar L_{peak} sound levels at each of the three monitoring locations throughout both of the shooting sessions.

In summary the sound levels emanating from the shooting of weapons at both proposed shooting range sites did not produce sound levels at any of the three monitoring locations any greater than those sound levels emanating from extraneous sounds recorded during the sound study, and any other typical sounds that could be experienced at other times in those areas where the sound measuring was conducted.

H:\Projects\2013\1130132-01 NCWRC Sound Studies\Burke County\Drawings\FIRING RANGE SOUND MEASURING LOCATION MAP.dwg



LEGEND

-  PROPOSED SHOOTING RANGE SITE #1
-  SOUND LEVEL METER LOCATION
-  1/2 MILE DISTANCE FROM PROPOSED SHOOTING RANGE SITE #1



		<small>4301 TAGGART CREEK ROAD CHARLOTTE, NC 28208 704-304-8913 704-304-6958 fax www.shieldengineering.com</small>	
		<p>PROPOSED SHOOTING RANGE #1 AND SOUND MEASURING LOCATION MAP</p>	
<p>NORTH CAROLINA WILDLIFE RESOURCES COMMISSION DIVISION OF ENGINEERING AND LAND MANAGEMENT CREEDMOOR, NORTH CAROLINA</p>			
DATE :	09/01/13	DRAWN BY :	SMB
SCALE :	AS SHOWN	FIGURE :	1

L peak SOUND LEVELS

RECORDED AUGUST 14, 2013

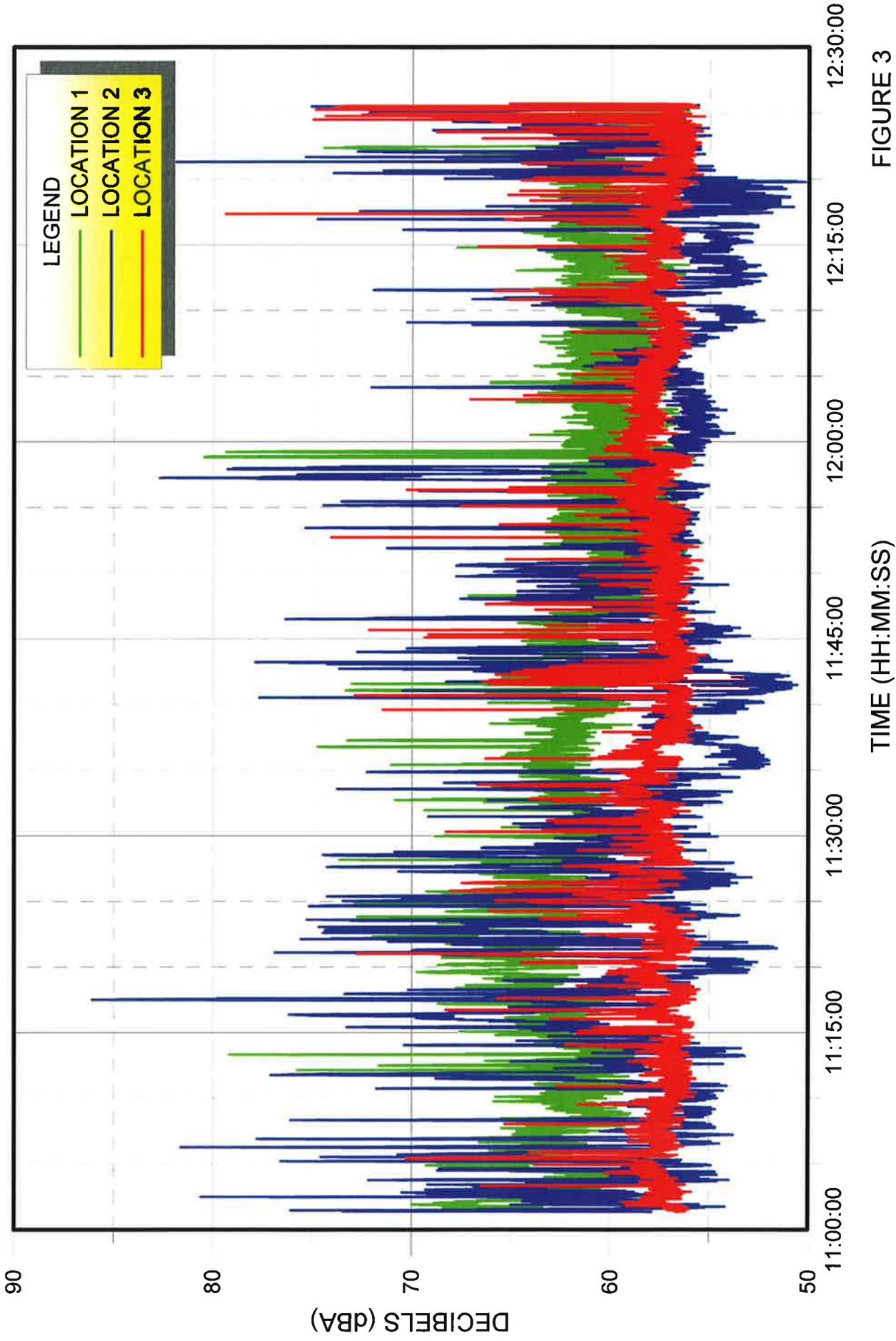
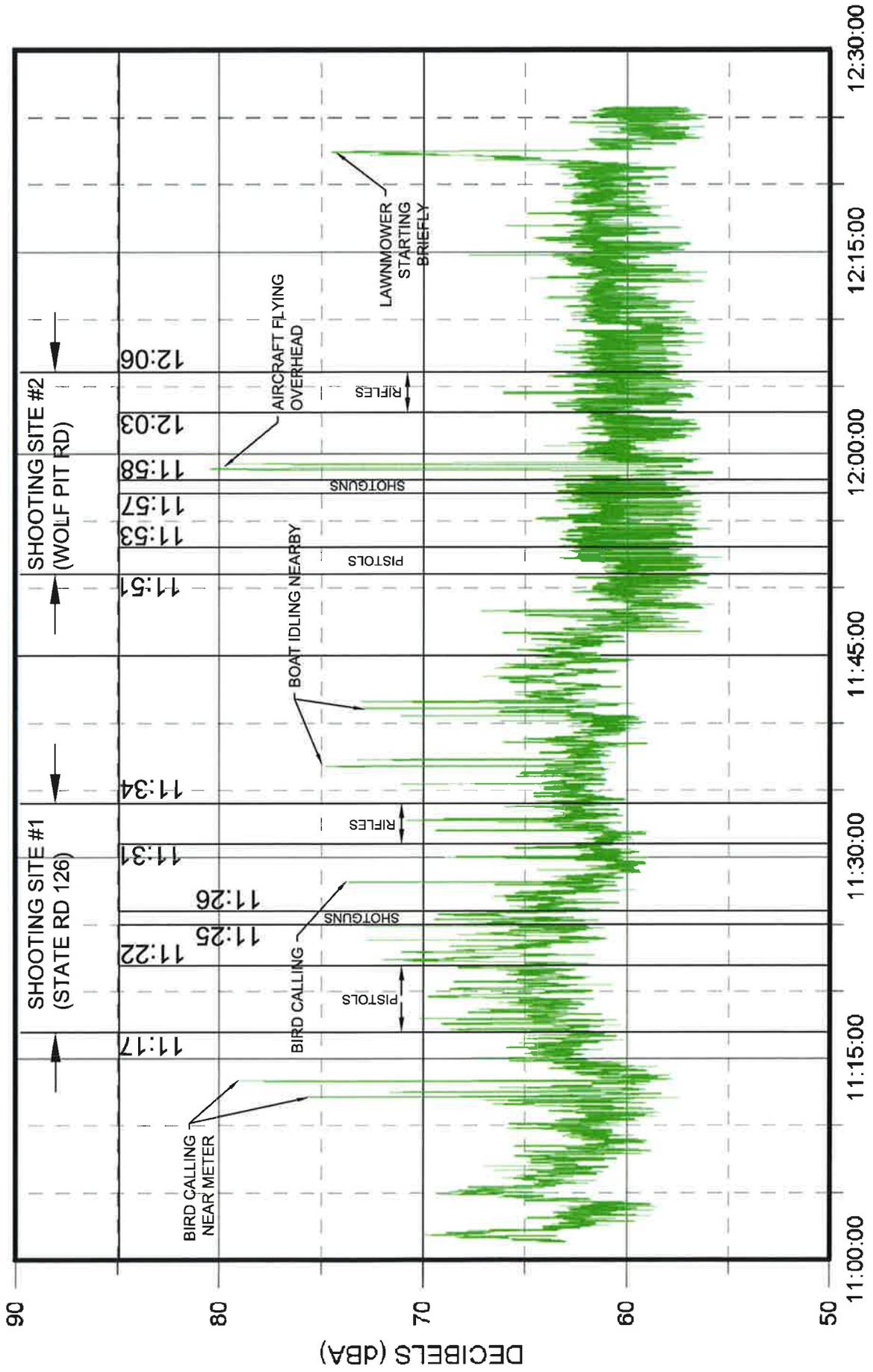


FIGURE 3

L peak SOUND LEVELS AT LOCATION #1

RECORDED AUGUST 14, 2013



TIME (HH:MM:SS)

FIGURE 4

L peak SOUND LEVELS AT LOCATION #2

RECORDED AUGUST 14, 2013

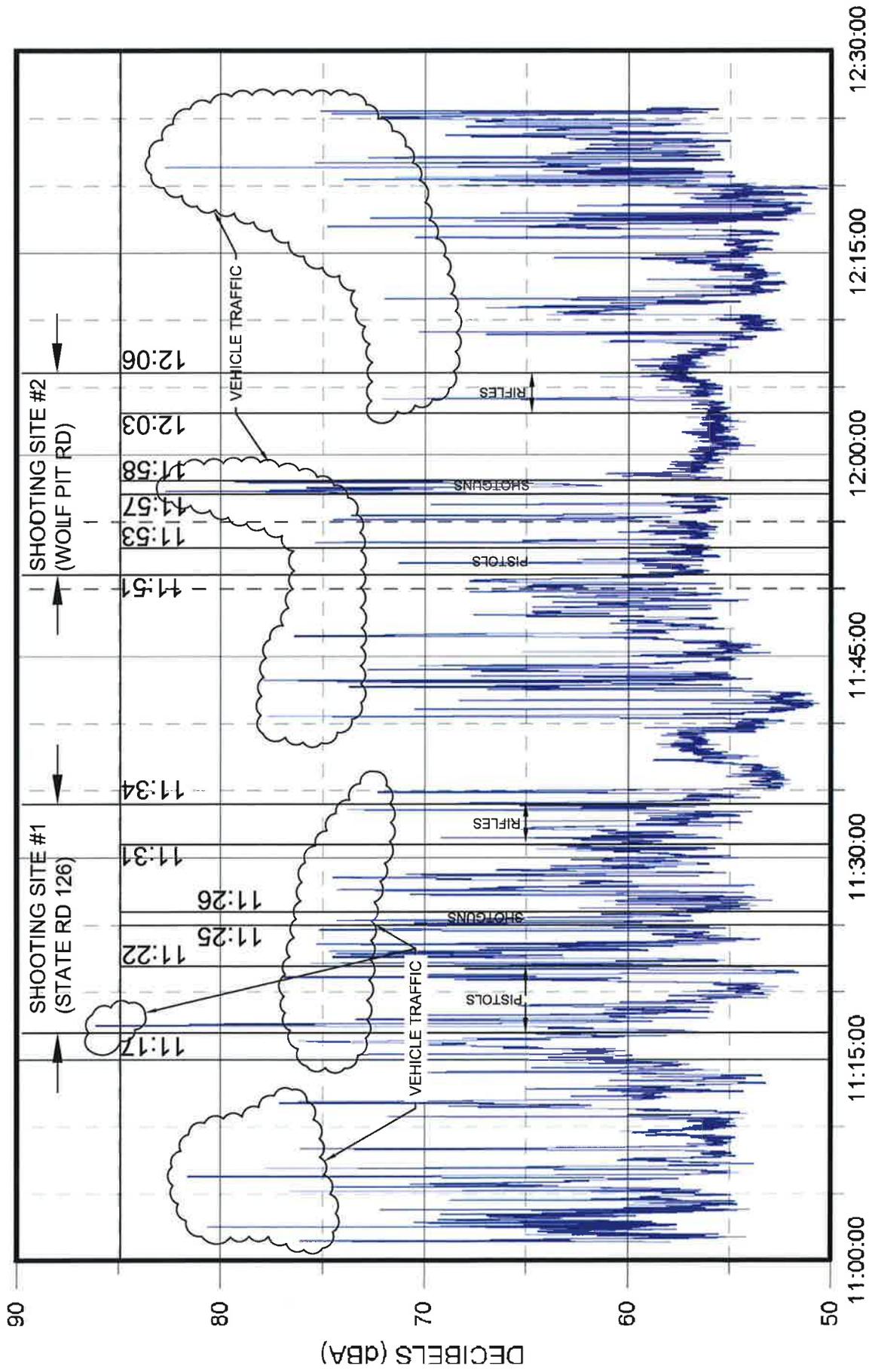
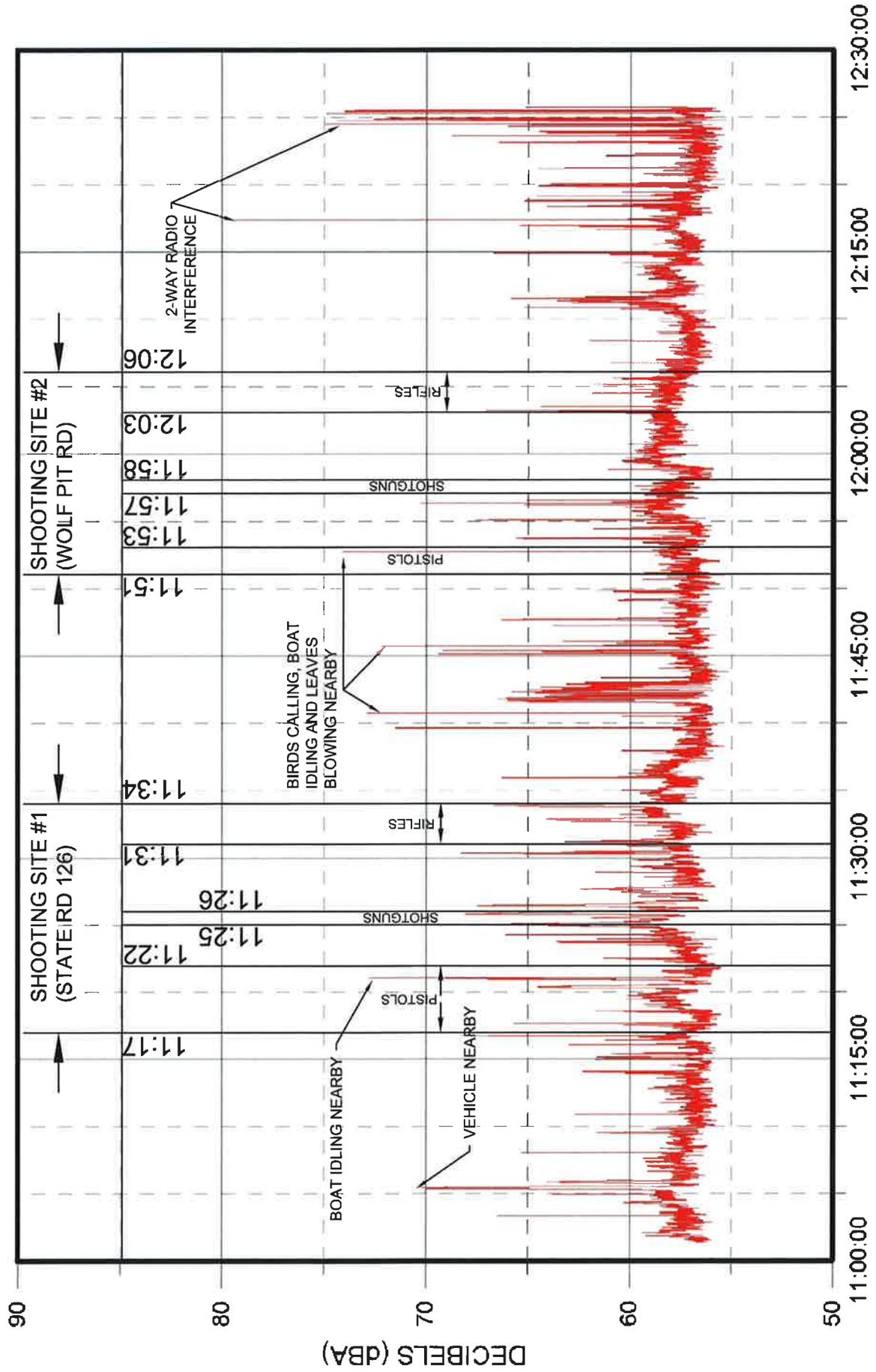


FIGURE 5

L peak SOUND LEVELS AT LOCATION #3

RECORDED AUGUST 14, 2013



TIME (HH:MM:SS)

FIGURE 6

**TABLE 1
 MAXIMUM (Lpeak) SOUND LEVEL (Decibels) AT MEASURING LOCATIONS BY WEAPON
 FOR BOTH FIRING RANGE SITES
 BURKE COUNTY, NC**

	SOUND METER LOCATION (see Figures 1 and 2)		
	Location #1	Location #2	Location #3
Maximum Lpeak for Period of Record (dBA) and Time of Maximum Lpeak	80.5 11:58:49	86.1 11:17:30	79.4 12:17:22
Distance from Proposed Shooting Range Site #1 (miles)	0.85	0.85	2.30
Maximum Lpeak for Pistols (dBA)	70.2	86.1	72.8
Maximum Lpeak for Shotguns (dBA)	69.5	74.3	68.1
Maximum Lpeak for Rifles (dBA)	70.9	73.8	66.7
Distance from Proposed Shooting Range Site #2 (miles)	1.0	0.83	2.45
Maximum Lpeak for Pistols (dBA)	63.4	71.3	74.1
Maximum Lpeak for Shotguns (dBA)	63.6	82.7	59.8
Maximum Lpeak for Rifles (dBA)	66.1	72.1	67.1
Maximum Lpeak for Period of Record excluding both Shooting Sessions (dBA) and Time of Maximum Lpeak	80.5 11:58:49	81.6 11:06:15	79.4 12:17:22

**TABLE 2
 AVERAGE (Lpeak) SOUND LEVEL (Decibels) AT MEASURING LOCATIONS BY WEAPON
 FOR BOTH FIRING RANGE SITES
 BURKE COUNTY, NC**

	SOUND METER LOCATION (see Figures 1 and 2)		
	Location #1	Location #2	Location #3
Average Lpeak for Period of Record (dBA)	61.8	58.9	57.9
Distance from Proposed Shooting Range Site #1 (miles)	0.85	0.85	2.30
Average Lpeak for Pistols (dBA)	64.4	60.1	57.7
Average Lpeak for Shotguns (dBA)	65.3	62.8	61.4
Average Lpeak for Rifles (dBA)	62.1	59.4	58.9
Distance from Proposed Shooting Range Site #2 (miles)	1.0	0.83	2.45
Average Lpeak for Pistols (dBA)	59.9	58.2	57.5
Average Lpeak for Shotguns (dBA)	60.6	70.0	58.0
Average Lpeak for Rifles (dBA)	60.3	57.1	58.3
Average Lpeak for Period of Record excluding both Shooting Sessions (dBA)	61.8	58.7	57.8

TABLE 3
TYPICAL SOUND LEVELS (Decibels) FOR COMMON SOUND SOURCES
BURKE COUNTY, NC

Type of Sound	Sound Levels (dBA)
Normal Conversation (3' to 5')	60 - 70
Passenger Car at 50mph (50 Feet from car)	65 - 72
Home Vacuum Cleaner	70 - 75
Telephone Dial Tone (typical desk phone)	80
Garbage Disposal at 3 Feet	80
Diesel Truck at 40mph (50 Feet from truck)	80 - 90
<i>Level at which Sustained Exposure may result in Hearing Loss</i>	90 - 95
Electric Food Blender at 3 Feet	90 - 95
Walk-behind Power Mower at 3 Feet	95 - 107
Electric Powered Saw at 3 Feet	110
Sandblasting	115

References:

Noise - Basic Information, Canadian Center for Occupational Health and Safety,
September, 2006

Chasin Marshall, 2007 Sound Study for Center for Human Performance & Health,
Ontario, Canada

APPENDIX A



Photograph No.1 - Sound Measuring Location #1



Photograph No.2 - Sound Measuring Location #1



Photograph No.3 - Sound Measuring Location #2



Photograph No.4 - Sound Measuring Location #2



Photograph No.5 - Sound Measuring Location #3



Photograph No.6 - Sound Measuring Location #3