15 July 2014

Environmental Assessment of The Linville Shooting Range NCWRC Linville Tract, NC/ Burke County

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INTRODUCTION

The North Carolina Wildlife Resource Commission (NCWRC) has expressed an initiative to improve game lands and develop firing ranges to aid in the management of small arm/rifle practice firing and minimization of open field firing where not necessary. As part of this initiative, the NCWRC has proposed a dual line firing range interior to the existing NCWRC Pisgah Game Land, Linville River Tract. The proposed range is located on the southern portion of the Linville River tract, approximately 500' from HWY NC 126. There is a ridgeline that separates the site from the highway and an existing access road to the site. The total tract of land where the development is to occur is 1,336 acres. The area for disturbance is approximately 3.5 acres or 0.26% of the entire tract. The site is located at the approximate coordinates and is shown in the following figure:

35.80072°N, -81.87278°W

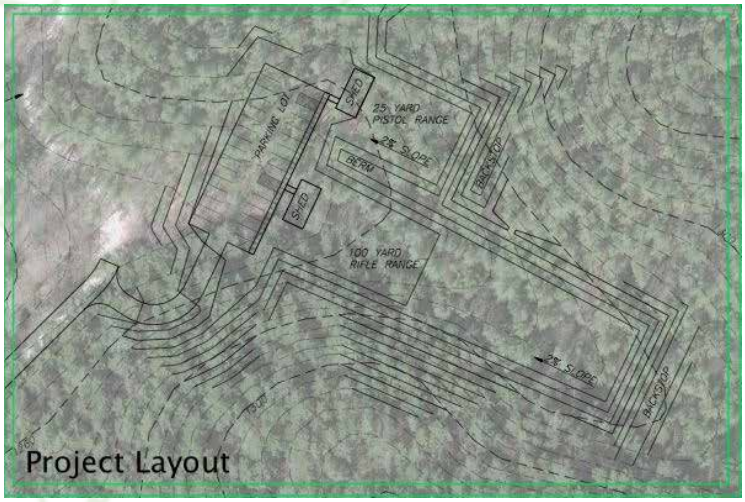

Figure 1. Proposed Compact Shooting Range

The tract is already owned, managed and operated by the NCWRC making it an ideal area for the development of this project. The area is physically and ecologically suitable from an environmental standpoint. Implementation of the project at this location will have net positive environmental impacts on site and in the community. Net environmental impact analysis is the evaluation of the cumulative impacts of a project where some minor impacts can be offset by major environmentally positive impacts. In the case of this proposed project the positive impacts significantly outweigh any potentially negative impacts. In the development and construction of the site, standard construction BMPs will have to be used and an on-going environmental stewardship

plan is recommended. It is expected that the presence of the NCWRC range at the site will (1) ensure the watershed is improved from current conditions, (2) bring an estimated 3000-6000 kg of lead shot into a controlled manageable area that would otherwise be discharged in an uncontrolled manner about the community and/or gameland, and (3) improve environmental education and stewardship in the area. The following document outlines the critical environmental issues on site including (a) project background, (b) purpose and need for action, (c) alternative analysis, (d) regulatory considerations, (e) net environmental impacts, (f) flora/fauna considerations, (g) soils considerations, (h) surface water considerations, (i) ground water, (j) lead deposition, (j) local influence analysis, (k) socio-economic analysis, (l) heritage/previous land use, (m) general observations, (o) topology, (p) recommendations, and (q) conclusions. The figure below shows the site vicinity relative to Lake James.

Figure 2. Project Vicinity

PROJECT BACKGROUND

As lands in North Carolina (NC) become more densely populated and urban sprawl expands into rural areas, it is important that safe and environmentally friendly areas for sport hunting and target shooting exist. As residential areas encroach on conservation lands, national forest, and game lands, buffer zones become scarcer, resulting in immediate transition from developed residential property to game lands. This has the potential for future safety issues where game lands exist and

will ultimately result in increased used of game lands. Increased use of game lands implies that more shot will be fired per annum and resultantly more shot will be deposited in uncontrolled areas. This increased use corresponds with ongoing population densifications across NC. The intent of the development in the Pisgah Game Land, Linville Tract, is to provide an area where target shooting can be carried out with relatively easy access to prevent uncontrolled practice shooting, improve environmental stewardship and awareness, and improved shooter safety. The firing range may be used as a location to support hunter safety courses and proper firearm use. The comprehensive impacts of a shooting injury are substantial. Improving shooter aptitude through training at the future range will reduce the risk of shooter injury and subsequent impacts. Comprehensive impacts from injury include costly emergency transport from remote areas, impacts at place of medical care, and community impacts. The following figure shows a recent map of the Linville Tract that additionally demonstrates the proximity to other property uses.

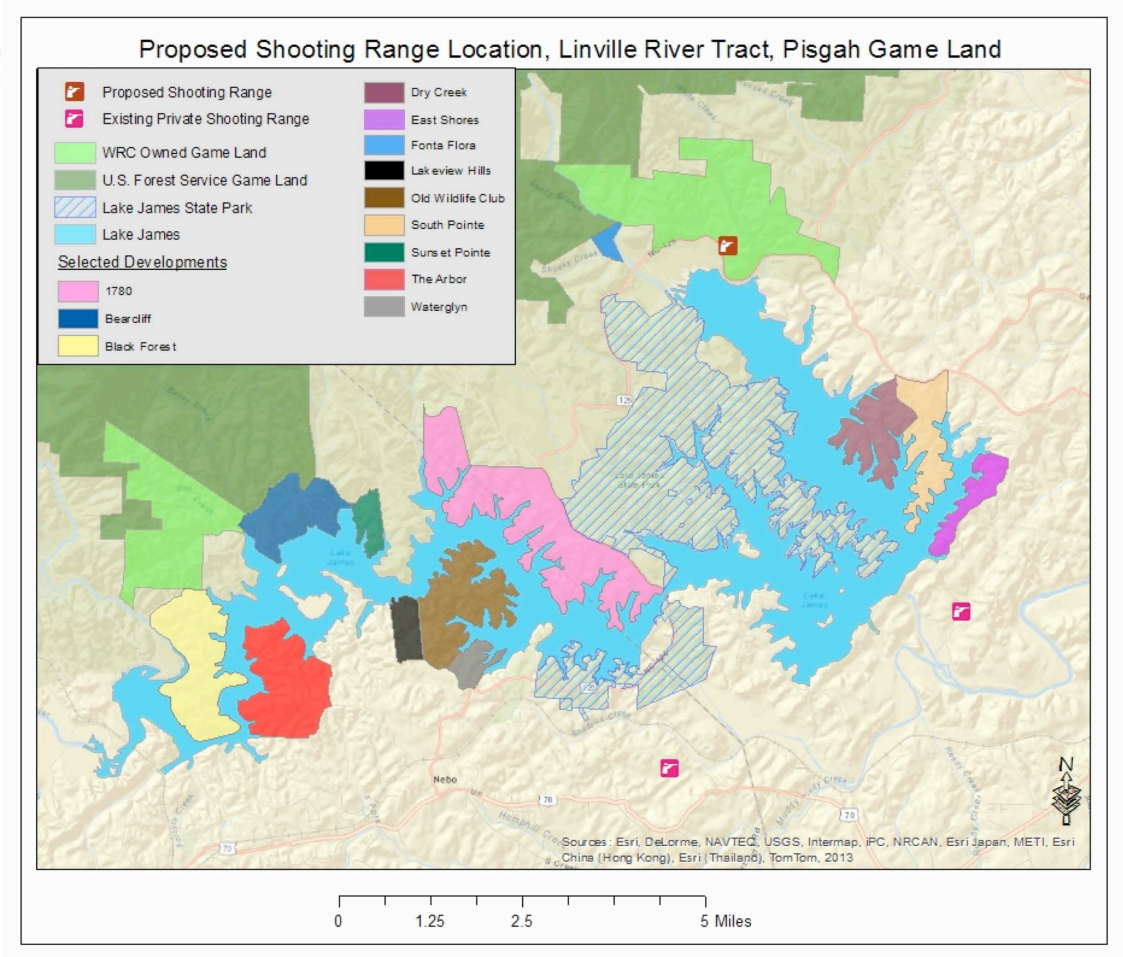

Figure 3a. Existing Published Game Land Map by NCWRC

PURPOSE AND NEED FOR ACTION

The primary purpose of the proposed project is to provide an area where sportsmen/ sportswomen can practice rifle and small arms firing. Secondary purposes include increased NCWRC presence in the area, improved environmental awareness and stewardship, and improved management of the Linville tract. Multipurpose infrastructure with multiple environmental goals have proven to be cost effective and address multiple environmental concerns at once on reduced budgets. An objective of this project is to reduce environmental impacts on other sites by attracting existing shooters to a controlled range thereby reducing the amount of uncontrolled lead deposition on other private and public lands. An approximate estimated minimum of 3000 kg of lead per annum is expected to be offset from contamination of, or exposure to other environments. These may be public or private lands. Ultimately an environmental cost will be born by the state for every day this project is not implemented, as it is assumed practice shooting will continue to take place in uncontrolled areas.

ALTERNATIVES ANALYSIS

After discussions with the NCWRC, it was apparent that other sites were considered in the local area for development. Other sites considered were not on NCWRC managed lands and required property acquisition. The current site was selected for several main benefits that would minimize impacted areas that were not available on other sites. This includes the following:

- Topology to minimize sound issues to adjacent properties.
- Small catchment area.
- Existing access to site not requiring additional impacts.
- No-rezoning, existing site is already game land.
- Opportunity to control and manage lead.
- Opportunity to improve shooter competence.
- Opportunity to improve local environmental stewardship.
- Ease of site implementation.

After discussions with Little Environments PLLC, other benefits of the site were recognized. These include but are not limited to the following:

- Opportunity to improve environmental awareness.
- Opportunity to offset uncontrolled lead deposition on other properties.
- Opportunity to restore hydraulics of the catchment with ease.
- Opportunity to address existing erosion issues as a result of the non-engineered road.
- Environmental opportunity cost of not implementing the project.
- Environmental stipulations already in place requiring utmost environmental performance. (See Figure 3b below requiring minimal development impact zones and minimal work zones)

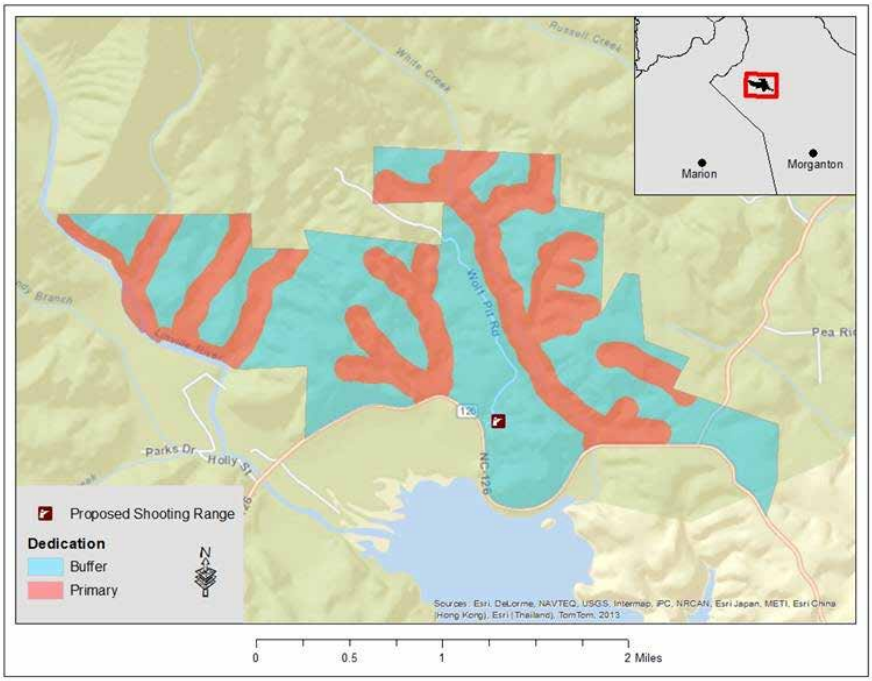

Figure 3b. Donor Environmental Development and Use Restriction Zones on Site

Considering the above points of donor mandated environmental buffer performance, the results of the site investigation, supporting research and analysis, the current site is a very good site for the implementation of the small shooting range.

REGULATORY CONSIDERATIONS

The following laws or policies are relevant to the site in regards to environmental issues.

Table 1. Environmental Ordinances/Laws Applicable to Site

Ordinances/Laws	Relevance
Sec802-Setbacks	Satisfied by preliminary design.
Sec803-Watershed Act	References state laws, see 401/404 permitting with NCDENR.
Sec902-Schedule of permissible uses	Does not specifically comment on shooting ranges on project specific land use.
Sec1106-Buffering and Screening	Satisfied by preliminary design.
Sec1116 –Shooting Range(outdoor) *SEE APPENDIX C*	Buffer from residential zone must be established. See figure below. Satisfied.
Sec1208-Natural Woodland Buffer	Not Specifically applicable.
Sec1209-Stormwater and Erosion Control Plan	Engineering sealed stormwater plan will be required. Reference ordinance specifically.
Sec1306-Site Plans	Provides specifics for requirements of final plans.
Sec2110-Access Management	Expected that a brief traffic study will be necessary. Sec2110.5- Shared Access may apply in regards to maintenance.
Sec2116-Presercation of cultural and historic sites	Project shall be designed to preserve or enhance ecological character.
Sec2117-Compatability with Public Natural areas or conserves land.	Site shall be compatible with the rest of the Linville Tract and include value/educational signage.
RCRA/CERCLA(Federal)	The lead shall be managed and kept on site in a safe manner for later removal/treatment. Impacts shall be minimized.
401/404 Permitting	See Above

*Additional regulations may apply beyond environmental regulations

The figure below is composed to demonstrate compatibility with county ordinance 1116-Outdoor Shooting Ranges. The current design satisfies this ordinance and meets the 1,350' buffer with a 30-40' berm on the south side of the site to intercept stray bullets. It is understood that this area is required for misfire contingency and the majority of lead is to be intercepted by the backstop.

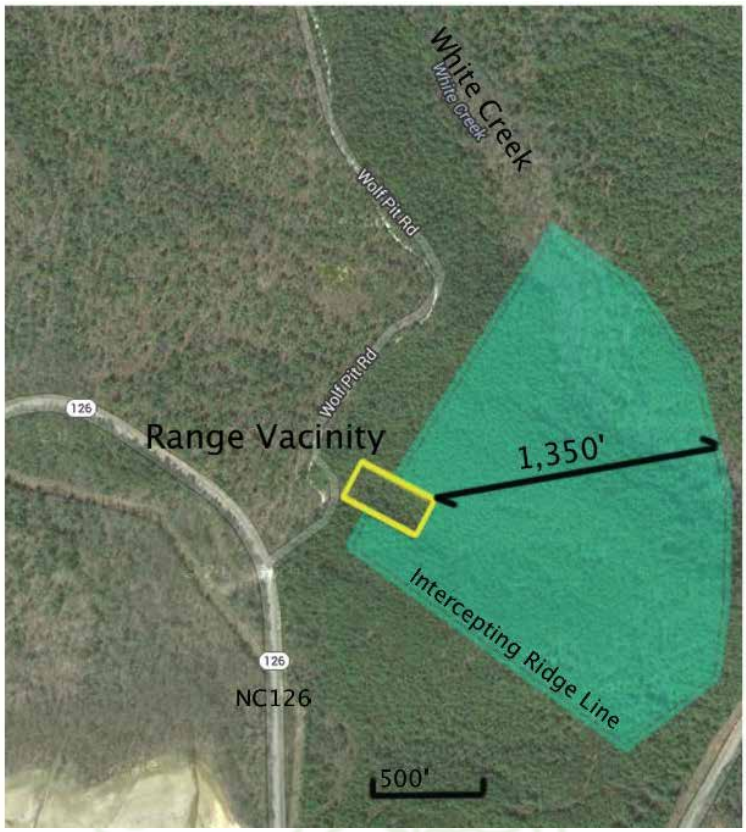

Figure 4. No Residential Buildings in Overshot Area per Ord1116

NET ENVIRONMENTAL IMPACTS

The purpose of the shooting range proposed on the Linville tract is to provide a safe area for targe shooting that will allow control of lead deposited on game lands. Resultantly, the project at this location will have net positive environmental impacts on site and in the community. Net environmental impact analysis is the evaluation of the cumulative impacts of a project where some minor impacts can be offset by major environmentally positive impacts. In the case of this proposed project the positive impacts significantly outweigh any potentially negative impacts. The site, composing less the 0.3% of the entire tract will improve safety, environment stewardship, and management of lead. Ultimately the significantly limited development of this site into a shooting range will have no significant environmental impact and will offset other existing environmental impacts.

FLORA/FAUNA CONSIDERATIONS

The site was inspected at approximately 3:30 pm on the 20th of June, 2014 for present flora and fauna. The temperature at the time was about 85 degrees Fahrenheit. No significant fauna was observed nesting in the area or traversing through the area. Flora was observed and is reported hereafter. Biodiversity in the area is extremely similar to the rest of the 1,336 acre tract. Examining

the area for development from a wildlife corridor standpoint suggests no significant impedance to wildlife in the area. The site is located at the periphery of the property and adjacent a commonly travelled roadway. The adjacent catchments, not directly impacted in this project, of the Linville River and White Creek are more likely to be used for wildlife corridors due to the presence of continuous flowing water and easier terrain.

The 3.6 acres that were inspected included intermediate to secondary growth forest with predominate fern undergrowth. Some other typical species existed, such as poison ivy, but not in abundance. Travelling further up Wolf Pit Road into the NCWRC tract, the same type of forest and undergrowth exists. The clearing of the area will reduce the amount of secondary growth in the area by a marginal 0.26%. This impact is not significant. Replanting timber in adjacent areas after the construction of the firing ranges will help off set the minor environmental impact and help reduce noise transfer. Further in the area for development, near where the backstop for the site is proposed, there are large amounts of *Rhododendron maximum. Rhododendron* is common in the area and is not endangered.

Intermediate to secondary trees present include red maple, eastern hemlock, virginia pine, eastern white pine, red spruce, and American beech. Tree diameters in the area for development did not exceed 24" and were commonly around 16".

Photos of predominate landscape and floras are shown in the figures below.

Figure 5a. Hemlock Tree Present

Figure 5b. Predominant Fern Undergrowth

Figure 5c. Understory Fern Growth

Figure 5d. Existing Intermediate Growth Forest

SOILS

Soils on site were tested across the base of the catchment where the proposed shooting range and parking lot will exist. The results of the soil observations are found in table 2 along with comments on the quantitative soil testing. Overall there were no significant existing concentration of lead or other heavy metal and other nutrients were of natural concentration and non-toxic. Figure 6 below shows the locations of each soil sample.

The type of soil in the area of the site ranges from a clayey silty material to a clayey loamy material with presence of sand. The soils in the area are significantly anthropogencially influenced on the access road and adjacent to the access road. The access road has been in use for approximately 100 years and is a gravel access road. The road is shown on the 1920's archive documents with an alternative name of National Park Rd. Above the road area, in the immediate catchment there is little area for rainfall collection and subsequent soil transport and hence the top soil layers are mainly products of decayed plant materials. This is supported by the high acidity of the soils and presence of evergreen needle comprising vegetation.

Table 2. Soil Sample Observations and Interpretation from Test
(Test Results in Appendix A)

Sample Reference Number*	***Area Description***	***Soil Type***	***Comment on Results***
4	Future Pistol Range Floor	Dry Silty Clay	Rather Acidic/ Low Cation Exchange Capacity
5	Future Rifle Range Floor	Clay with some Silt	Rather Acidic/ Low Cation Exchange Capacity
6	Future parking Lot	White Clay	Acidic/Very Low Cation Exchange Capacity
7	Upslope side of access road	8" organic bog atop clay	Rather Acidic/ Low Cation Exchange Capacity
8	Adjacent access road, down slope	Sandy Clayey Silt	Neutral pH/ Very Good Cation Exchange Capacity for Range
9	Mid-gully between access road and hwy gully intersection	Silty Clay	Neutral pH/ Good Cation Exchange Capacity for Range
10	Boggy area adjacent hwy and down stream from site	4" organic bog atop clay	Moderately Acidic/ Moderately Low Cation Exchange Capacity

* Sample boxes 1-3 not used

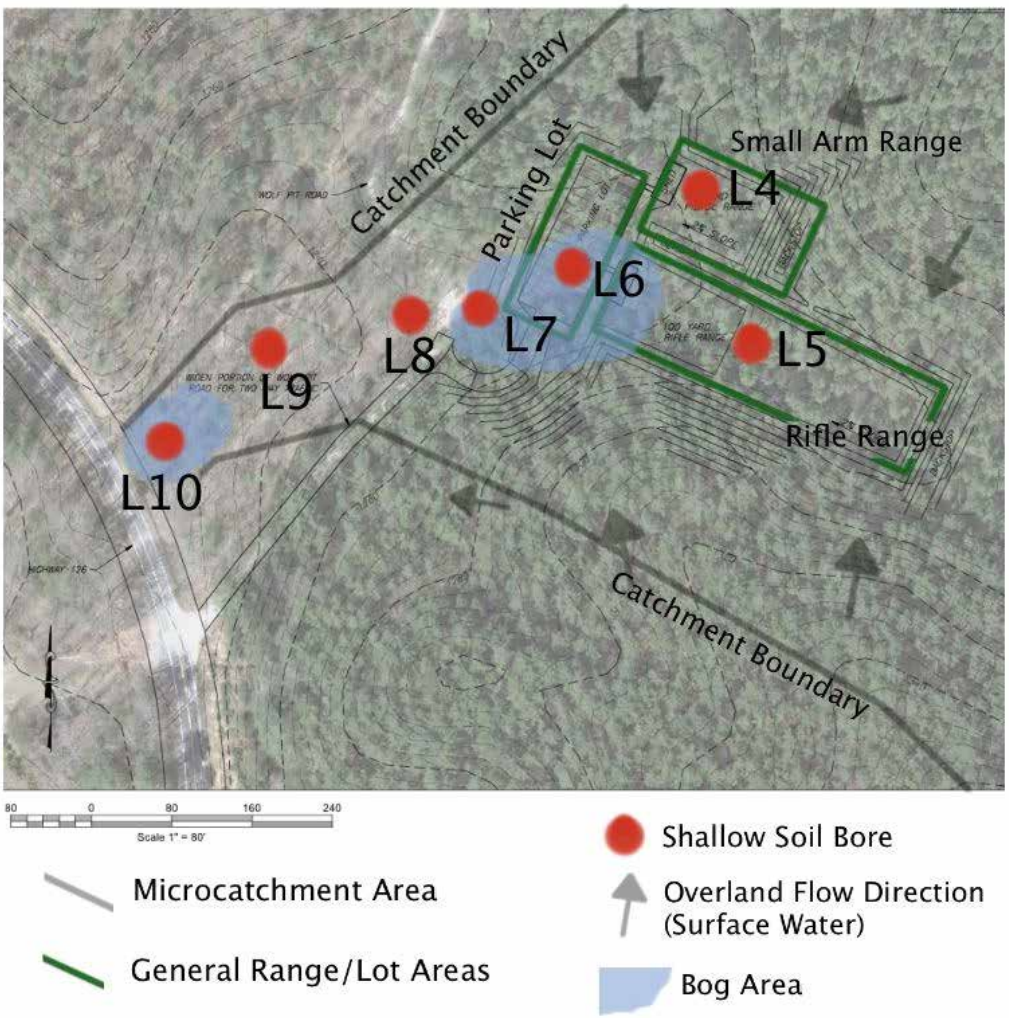

Figure 6. Location of Bore Samples

Due to the presence of highly acidic soils on site, caution should be taken in any construction or earth moving process so that this acidic soil is not liquefied, mobilized, or eroded to Lake James. The high acidity soil should be managed to best management practices to prevent an acidic shock to Lake James resulting in potential but short-term, localized oxygen depletion.

In summary the soil to the east of the area for development as a shooting range is good quality clay and well drained. Going down hill and moving west, the soil becomes of a boggy state, transitioning to clay at typical depths of 8” to 1’. The existing access road acts as a mini-dam or water retention structure and creates the bog area. Under the road and down-slope from the road, there is a presence of high quality clays with good cation exchange capacity. Due to this good cation exchange capacity the material potentially would work well for shooting range backstop and

shooting range floor material. Recommendations will be made later for the movement of material from this area to future range floor areas.

SURFACE WATER

Surface water is especially important to manage on shooting ranges. Surface water should be managed so that velocities do not exceed critical rates that will mobilize local soils. There are several aspects that contribute to the surface water conditions in the site for development. These existing aspects are (1) human interaction, (2) previous access road placement, (3) establishment of an unnatural bog, (4) the small size of the catchment, and (5) general vegetation. Prior to the installation of Wolf Pit Rd(Originally National Park Rd) and Hwy NC 126, the surface water in the area flowed downhill into Lake James(or the Linville river prior to 1923) at a steady rate. After the construction of the raised Wolf Pit Rd and HWY NC 126, reactionary environmental effects were the creation of two boggish type areas. The first area is up slope from the bend in the access road and adjacent the proposed site. The second area is adjacent NC HWY 126 .

It is suspected that the existing access road was installed in a logging or agricultural approach without detailed design. The access road has been continuously maintained over approximately 100 years.

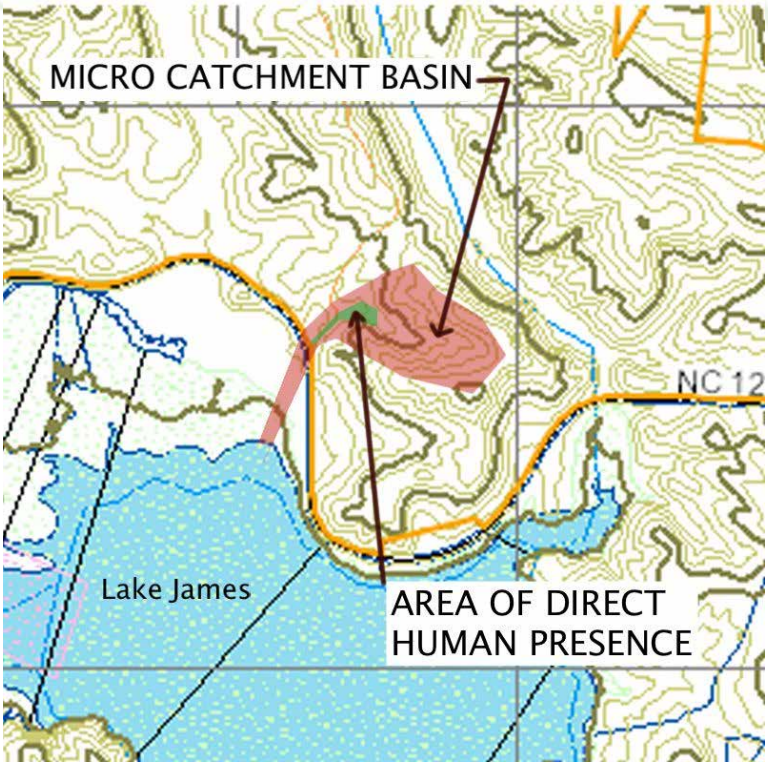

Figure 7. Catchment Basin for Project, Small Basin or Micro-Catchment

Resulting from of the manmade bog were the establishment of ferns and bog vegetation, deposition of loam, silt, and detritus, and the destabilization of several large tree root systems. These effects were witnessed on site. Figure 8, below, was taken immediately adjacent the future shooting range site. The photo shows significant vehicle rutting compounded with standing water in the access road. This is a result of drivers veering off the road or temporarily parking and then attempting to exit the soft soils. The implementation of a designated parking lot would address this erosion issues and surface water impediment and provide adequate parking.

Figure 8. Rutting/Erosion on Existing Access Road

Overall, the selection of the basin is perfect for use as a shooting range. The basin is of a small size compared to the adjacent basins. Up hill from the future site there is very little area for the collection of rain and subsequent overland flow, further reducing the risk for future lead mobilization or erosion. Effectively, the basin is a microbasin that can be effectively controlled with simple engineering, environmental restoration, and best management practices.

GROUND WATER

The proposed site for the project is expected not to have any adverse issues associated with groundwater infiltration of contaminants entering the ground water due to the shallow earthworks typically associated with shooting ranges. The site is located between 35’ and 60’ above the water level of Lake James. The significant water table is expected to be at the lake elevation or just higher.

If the quality clay on site is utilized in combination with a liner and clay improvement methods, any potential groundwater threat can be easily negated. As this range is a solid bullet use range, smeared or dissolved components of bullets (lead) are not heavily expected, making retention of lead in the backstop and the range floor very easy with select engineering BMPs and clay improvement. A clay thickness of 1-2 feet for the range is expected to be satisfactory in light of a more detailed design liner system.

LOCAL INFLUENCE ANALYSIS

In regard to the project objective of attracting target shooters that would otherwise practice on uncontrolled land, it is important to consider the area of customers or users of the site. From the total expected customer base, the quantity of lead deposied can be estimated and is done so later in this document. Various factors contribute to the annual use of a rifle site, including ease of access, knowledge of the site, percent of hunters or gun sportsmen/sportswomen in the area. To be influenced by the site, the user must visit the site and take appreciation of the site and what it has to offer. Figure 9, below shows two radii of 10 miles and 20 miles. Within this area there are several large towns whose populations are expected to make up a significant portion of the site's users. These towns and near proximate towns include Morganton, Valdese, Marion, Nebo, Linville, Collettsville, Gamewell, Hudson, Sawmills, Granite Falls, and Lenoir. These radii encompass mainly a large portion of McDowell County and Burke County. Total populations for McDowell County and Burke County are provided in table 3, below.

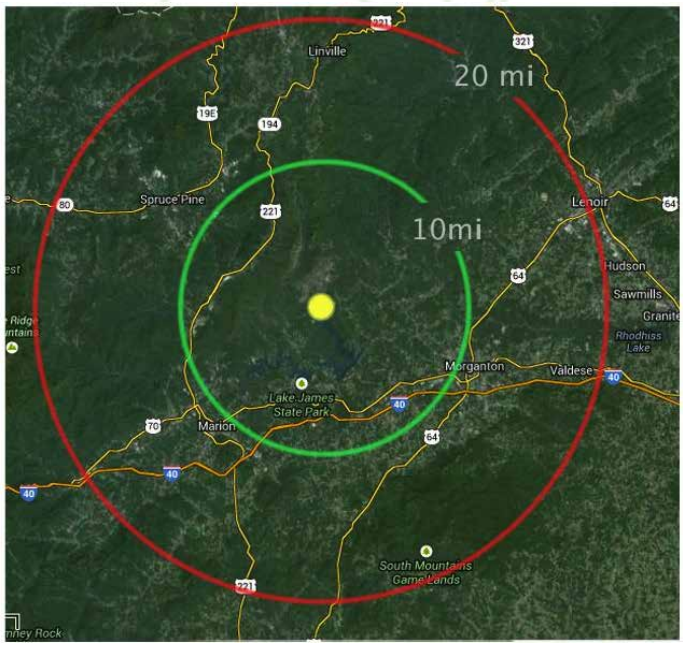

Figure 9. Radial Chart for Approximate Distance Travelled

With a total combined population of 135,908 persons, the population of McDowell County and Burke County make up the primary potential users of the Linville Tract shooting range. State wide statistics published by the national fish and wildlife service, developed from surveys, indicate that approximately 8% of North Carolinians go hunting or shooting each year. Applying this statistic to the total population of Burke and McDowell County provides a potential number of site users of 10,872 persons. It is expected that the total number of visitors will be less, as other hunting preferences exist such as clay or bird shooting over fixed range shooting, however the 10,872 person estimate is a good outreach example based on conservative assumptions. The number above does not consider tourist use or long travel use and is based on the average commute time travel to work of 15-20 minutes being a reasonable time to travel to a location of recreation shooting.

Table 3. Population of Significant Counties Influenced

	BURKE	MCDOWELL	COMBINED
Urban population	52,136	13,363	65,499
Rural population	38,776	31,633	70,409
Total population	90,051	44,996	135,908

* Population statistics are from NC Department of Commerce 2011 Census

Figure 10, below is the NCDOT map of the local area. The site is approximately 10 miles from I-40 and immediately adjacent the Pisgah national Forest. The site has high potential to attract tourist that are visiting Lake James, visiting Pisgah National forest, or already visiting the Linville tract for hunting purposes. The area also has the potential to serve as a site for warm up or calibration prior to the use of the Linville NCWRC tract for hunting.

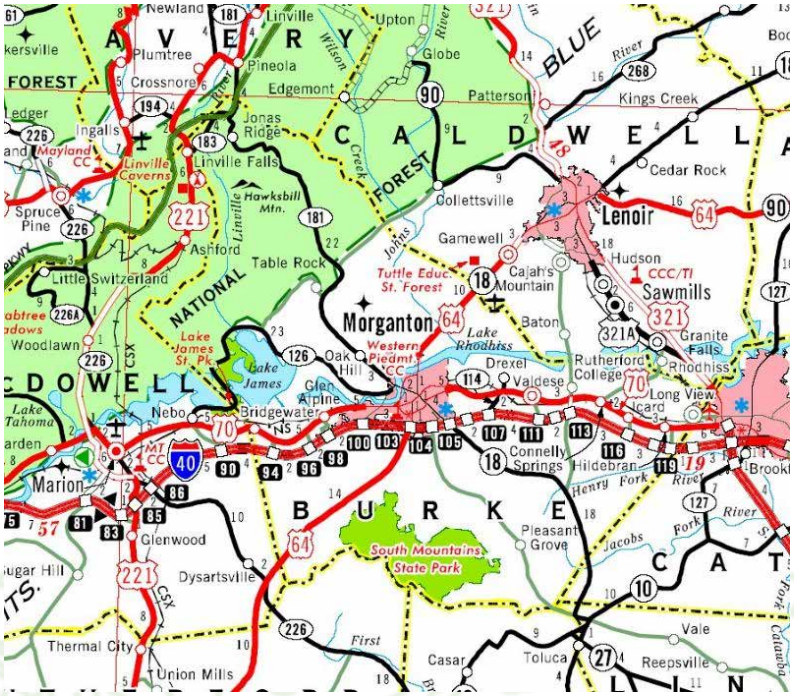

Figure 10.NCDOT Highways Map

The more people that use the site, the more lead will be diverted from uncontrolled practice shooting areas and resultantly more environmental impacts on other properties will be offset. Outreach to the populations including wildlife officer engagement and signage information at site will promote environmental stewardship.

LEAD DEPOSITION

Lead deposition on site is expected to be a function of the total users that visit the site. The site is for rifles and handguns only, with the most common caliber bullets expected to be between 45mm and 9mm. Bullets of these calibers can range between 7.5 grams and 12 grams with 10 grams being the typical maximum used recreationally. Assuming that the typical site user or customer fires on average 45 shots, the lead deposited per user could range between 337.5 grams and 450 grams. This makes the number of users that visit the site a critical variable in estimating the lead loading capacity of the site. The lead loading capacity will need to be met with a design by an engineer to support such shooting and user visit frequencies.

Two general methods can be used to determine the number of potential visitors to the site or control the number of visitors to the site. The first method is to estimate the number of users based on available parking. Effectively the number of parking spaces available can be used to control the amount of lead deposited on the site or the number of users can be determined based on the expect out reach of 10,872 persons, as estimated in the previous section. 30 parking spaces are available in

the plan for the site. Assuming 200% usage on the weekends, where each space will be filled twice, and 15% usage on each weekday(4.5 visitors per weekday) the estimated number of visitors is 262.5 users per week or 13,650 users per annum.

Table 4. Estimated Lead Deposition in Linville Tract Shooting Range

Guest Method	Lower or Higher Lead Shot Per Person(g/pp)	No. of Guest (persons)	Estimated Volume of lead Deposited per Annum (kg)
From Influence or Outreach	337.5g/pp	10,872	3669.3kg pb [8072.46lbs]
From Influence or Outreach	450g/pp	10,872	4892.5 kg pb [10763.5lbs]
Based on Parking Control	337.5g/pp	13,650	4606.9 kg pb [10,135.2lbs}
Based on Parking Control	450g/pp	13,650	6,142.5kg pb [13,513.5lbs]

SOCIO-ECONOMIC ANALYSIS

As part of the environmental assessment, improvements to quality of life in the area and improvement to socio-economic and environmental-economic are likely. As the site is to be developed in an ecological manner in regards to county ordinance section 2116, environmental, social and economic returns are expected. Social and environmental returns include improved environmental stewardship, environmental education, gun safety education, and improved amenity of the area. Direct economic returns include sales of related gear in the area such as meals, fuel, lodging, safety equipment, and ammunition. Economic opportunities also include job creation and the use of the site for ecotourism or sporting tourism. Between McDowell county and Burke County 17,246 students are enrolled in grades under 12th grade. Social benefits exist as the site can be used for education purposes in relation to Boy Scouts of America, Indian Guides, and other outdoor education opportunities. Establishing a sense of environmental stewardship at a younger age has proven to result in lasting appreciation and respect for the environment. Implementing education signage at the facility will help this. Of the 43,887 jobs in McDowell County and Burke county only 109 jobs are in the agricultural forestry and fishing industry. The establishment of this site adds

potential to improve this industry. The US Wildlife and Fisheries 2011 survey indicates that on hunting trips or on sporting trips the average hunter spends $1,556.00. If only 2% of the projected visitors are from outside the local area, tourism to the site is expected to bring $338,000.00 in income to the local area. The potential social and economically related environmental impacts to the area are only positive.

HERITAGE/PREVIOUS LAND USE

The immediate land use of the site is a combination of access road area, impacted access road corridor, and impacted forest as part of the Pisgah National Forest. The adjacent and proximate proprieties predominately include Lake James, residential properties, and agricultural properties. The property to the south of the area of the shooting range development is owned by Duke Energy and is adjacent the lake.

Lake James is a man made lake created between 1916 and 1923 for the purpose of hydroelectric power by Duke Energy. The lake is a 6812 acre body of water and is name after the founder of Duke Energy, James B Duke.

A brief literature review of Burke County indicates that the history of the area may or may not have included aboriginal tribes with relation to the Mississippi Indians. These tribes may have been in the area 400-500 plus years ago. The "Joara" town or fort is location approximately 8-9 miles east of the site. It has been hypothesised that this area was the area visited by Hernando de Soto and the Juan Pardo Spanish expeditions (Beck et. Al 2006). The "Joara" site is an open archaeological site. Construction recommendations are made later.

GENERAL OBSERVATIONS

While visiting the site, several environmental observations were made that were relevant to existing uses of the site and current illegal uses of the site. Figure 12a and figure 12b below show examples of littler and dumping on the site. Additional to the examples below, motor oil bottles, plastic coke bottles, and lantern fuel containers were observed on site. Some of these articles are indicative of camping waste such as the beer can and lantern that were not removed from the site. Other articles, such as the motor oil bottle, are examples of the site being used for illegal dumping, as one does not need motor oil for camping purposes. These observations indicate that these impacts have occurred from 20 plus years ago until now.

Other observations were made that indicate the area is heavily anthropogenically influenced including the existence of what appears to be an existing, but slightly revegetated trail, levelled and cleared leading through the area of the future pistol range. Photos are included in appendix B. Although the area is beautiful to the eye and appealing from an intrinsic standpoint, other observations indicate the area has been and still is heavily anthropogencially influenced. This is supported by it close proximity to NC HWY 126 and the Wolf Pit Access Road.

Figure 11a. Existing Beer Can

Figure 11b. Decomposing Can/Muffler

TOPOLOGY

The topology of the site is ideal for the implementation of a shooting range. The development is located in a small micro-catchment of 3.6 acres that flows into Lake James. The site is ~35' above Lake James. In the area for development there is 20' of elevation change. Above this area there is an additional 40 to 45' of steep slope to aid in muffling sound and intercepting any misfires. The proposed development is optimal as it fits well into the existing topology and will involve only minor amounts of cut and fill to satisfy the new topology. The cut will be mainly in the east area where the bullet-receiving embankment will be and to the south in the southern dividing switchback. The fill area will mainly be in the unnatural bog area that was established when the access road was cut. The figure below shows the existing topology. The small basin also helps alleviate any stormwater concerns and transport of lead offsite. As an example and indication only, understanding that a storm water design still needs to be carried out, under an approximate 5 year occurrence storm of 1" depth, the entire volume of the catchment can be collected by a 6' by 45' by 45' basin. This implies that for the developed site, it will be easy to address the 100-year storm with BMP erosion plans.

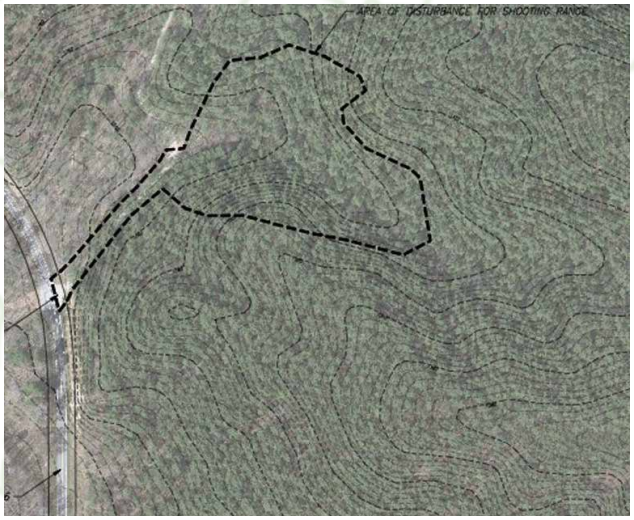

Figure 13. Site Topology

RECOMMENDATIONS

The following environmental recommendations are made in regards to the Linville Shooting Range:

1. Restore Surface water flows impeded by the access road.
2. Implement a catchment basin down catchment of the road. Additional micro bio-retention further up the catchment and interior to the site will aid in retaining lead on site.

3. Verify clay quality in the area of soil sample 8 and soil sample 9 and use this clay for additional range floor material where necessary.

4. In regards to regulations, a stormwater and erosion plan will be necessary. A traffic management plan may be necessary.

5. An environmental containment liner in combination with capping clay and backstop sand has proven to be a cost effective method in similar site conditions.

6. Ensure that acidic soils are not mobilized to Lake James or other surface waters, especially during construction.

7. Implement native vegetation on side slopes of the shooting range such as Rhododendron and ferns.

8. Although not probable, be wary of potential heritage artefacts, during construction and excavation. The could be Spanish or native American.

9. Implement a Range Environmental Stewardship plan to manage on-going environmental education to accompany firing safety, manage deposited lead, prevent mobilization of lead off-site, and generally maintain the site for good use.

10. Wildlife Resource Commission presence in the area will deter illegal dumping, campsite dumping, and littering and promote environmental stewardship.

11. Implement pervious pavements and geosynthetically-stabilized pavements for the access road.

CONCLUSIONS

The following conclusions are made in regards to the environmental assessment of the Linville NCWRC site:

1. This site can easily be engineered with best management practice to ensure no significant impact occurs and that the catchment is restored closer to original surface water conditions.

2. Improvement in environmental education and gun safety education will have significant environmental impacts that go beyond this site.

3. Concentrated use of the firing range will allow for better management of lead and less uncontrolled shooting across the entire 1,336 acre site.

4. A final design and site environmental steward ship plan should be carried out.

5. Implement signs that describe how the facility works in the existing environment to aid in improving local education. Inclusion of descriptions of designed BMPs on signage is also recommended.

6. The issue of public lands, in this case already public game lands, for human use versus environmental amenity will always be a long debate but the key to satisfying this debate is to promote environmental stewardship so that when the shooting range is constructed and used, it is done so in a way in which human and environmental interaction is positive and capacity building.

15 July 2014

FROM THE DIRECTOR

Little Environments PLLC thanks the NCWRC for the opportunity to carry out this study and analysis. Little Environments enjoys every opportunity to work with people and the environment, in the environment.

Best Regards,

Joseph Little PE/MIEAust
Managing Director

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NORTH CAROLINA PROFESSIONAL SEAL 040859 ENGINEER JOSEPH M. LITTLE

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NCDA&CS Agronomic Division **Phone: (919) 733-2655** **Website: www.ncagr.gov/agronomi/** **Report No.** FY15-SL000063

Heavy Metals

Soil Report

Mehlich-3 Extraction

Client: Mark Hamlet
1700 Varsity Drive
Raleigh, NC

Sampled County : Avery

Advisor: Joseph Little
3814 Cobb Street
Garner, NC 27529

Sampled: **Received:** 07/02/2014 **Completed:** 07/10/2014 **Farm:** L

Links to Helpful Information

Agronomist's Comments:

This report contains both routine soil test information as well as heavy metals data in a section labeled as Heavy Metals under soil test lab results. Using Mehlich 3 as a soil test extractant, background levels of these metals typically seen in NC soils when analyzed are as follows: arsenic (As)- 4.5 ppm, cadmium (Cd)- 0.1 ppm, chromium (Cr)- 0.2 ppm, lead (Pb)- 4.2 ppm, nickel (Ni)- 0.8 ppm, & selenium (Se)- 0.2 ppm (FY2005-2007). Although the above metals here are not believed to pose a concern for plant growth, continue to monitor these and note where elevated above background levels. Note any lime and fertilizer recommendations. Tissue testing is advised where pH is elevated and is of concern as in samples found here.Jagathi Kamalakanthan 7/9/2014

Sample ID: L4

Lime History:

Recommendations: Crop	Lime (tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	More Information
1 - Bermuda hay/past., M	1.0	180-220	140	180	0	0	0	$	0	0	Note: 12 Note: $
2 -							$pH				

Test Results [units - W/V in g/cm^3; CEC and Na in meq/100 cm^3; NO_3-N in mg/dm^3]: **Soil Class:** Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-AI1	Mn-AI2	Zn-I	Zn-AI	Cu-I	Na	ESP	SS-I	NO_3-N
0.32	0.92	2.8	44	1.6	5.0	4	25	27	12	53	170	119		19	19	56	0.0			

Heavy Metals (parts per million): **Arsenic,** 0.1 **Cadmium,** 0.0 **Nickel,** 1.0 **Chromium,** 0.1 **Lead,** 2.6 **Selenium,** 0.0

Sample ID: L5

Lime History:

Recommendations: Crop	Lime (tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	More Information
1 - Bermuda hay/past., M	1.4	180-220	140	180	25	0	0	0	0	0	Note: 12
2 -							$pH				

Test Results [units - W/V in g/cm^3; CEC and Na in meq/100 cm^3; NO_3-N in mg/dm^3]: **Soil Class:** Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-AI1	Mn-AI2	Zn-I	Zn-AI	Cu-I	Na	ESP	SS-I	NO_3-N
0.22	0.88	3.0	30	2.1	4.9	2	22	18	8	97	152	108		26	26	95	0.0			

Heavy Metals (parts per million): **Arsenic,** 0.1 **Cadmium,** 0.0 **Nickel,** 0.7 **Chromium,** 0.2 **Lead,** 3.2 **Selenium,** 0.0

NCDA&CS Agronomic Division **Phone: (919) 733-2655** **Website: www.ncagr.gov/agronomi/** **Report No.** FY15-SL000063

Mark Hamlet

Page 2 of 4

Sample ID: L6

Lime History:

Recommendations: Crop	Lime (tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	More Information
		Nutrients (lb/acre)									
1 - Bermuda hay/past., M	1.1	180-220	140	190	0	0	0	$	0	0	Note: 12 Note: $
2 -							$pH				

Test Results [units - W/V in g/cm^3; CEC and Na in meq/100 cm^3; NO_3-N in mg/dm^3]: **Soil Class:** Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-Al1	Mn-Al2	Zn-I	Zn-Al	Cu-I	Na	ESP	SS-I	NO_3-N
0.27	1.08	2.9	38	1.8	5.0	3	20	24	11	39	85	68		23	23	67	0.0			

Heavy Metals (parts per million): **Arsenic,** 0.1 **Cadmium,** 0.0 **Nickel,** 0.6 **Chromium,** 0.4 **Lead,** 6.7 **Selenium,** 0.0

Sample ID: L7

Lime History:

Recommendations: Crop	Lime (tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	More Information
		Nutrients (lb/acre)									
1 - Bermuda hay/past., M	0.8	180-220	140	200	0	0	0	0	0	0	Note: 12
2 -							$pH				

Test Results [units - W/V in g/cm^3; CEC and Na in meq/100 cm^3; NO_3-N in mg/dm^3]: **Soil Class:** Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-Al1	Mn-Al2	Zn-I	Zn-Al	Cu-I	Na	ESP	SS-I	NO_3-N
0.92	0.86	3.9	59	1.6	5.4	3	15	35	21	45	88	70		51	51	121	0.0			

Heavy Metals (parts per million): **Arsenic,** 0.0 **Cadmium,** 0.0 **Nickel,** 0.4 **Chromium,** 0.2 **Lead,** 4.0 **Selenium,** 0.0

Sample ID: L8

Lime History:

Recommendations: Crop	Lime (tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	More Information
		Nutrients (lb/acre)									
1 - Bermuda hay/past., M	0.0	180-220	140	130	0	0	pH$	0	0	0	Note: 12 Note: $
2 -							$pH				

Test Results [units - W/V in g/cm^3; CEC and Na in meq/100 cm^3; NO_3-N in mg/dm^3]: **Soil Class:** Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-Al1	Mn-Al2	Zn-I	Zn-Al	Cu-I	Na	ESP	SS-I	NO_3-N
0.13	0.92	12.2	100	0.0	7.5	4	41	86	12	28	251	145		47	47	164	0.0			

Heavy Metals (parts per million): **Arsenic,** 0.1 **Cadmium,** 0.0 **Nickel,** 0.9 **Chromium,** 0.2 **Lead,** 4.1 **Selenium,** 0.0

NCDA&CS Agronomic Division **Phone: (919) 733-2655** **Website: www.ncagr.gov/agronomi/** **Report No.** FY15-SL000063

Mark Hamlet

Sample ID: L9

Lime History:

Recommendations: Crop	Lime (tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	More Information
		Nutrients (lb/acre)									
1 - Bermuda hay/past., M	0.0	180-220	140	140	0	20	pH$	0	0	0	Note: 12 Note: $
2 -							$pH				

Test Results [units - W/V in g/cm³; CEC and Na in meq/100 cm³; NO_3-N in mg/dm³]: **Soil Class:** Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-Al1	Mn-Al2	Zn-I	Zn-Al	Cu-I	Na	ESP	SS-I	NO_3-N
0.22	0.86	8.2	96	0.4	7.0	2	40	66	28	18	246	150		60	60	151	0.0			

Heavy Metals (parts per million): **Arsenic,** 0.1 **Cadmium,** 0.0 **Nickel,** 0.7 **Chromium,** 0.4 **Lead,** 5.1 **Selenium,** 0.0

Sample ID: L10

Lime History:

Recommendations: Crop	Lime (tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	More Information
		Nutrients (lb/acre)									
1 - Bermuda hay/past., M	0.0	180-220	140	180	0	20	pH$	0	0	0	Note: 12 Note: $
2 -							$pH				

Test Results [units - W/V in g/cm³; CEC and Na in meq/100 cm³; NO_3-N in mg/dm³]: **Soil Class:** Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-Al1	Mn-Al2	Zn-I	Zn-Al	Cu-I	Na	ESP	SS-I	NO_3-N
0.18	0.97	5.9	88	0.7	6.5	4	25	58	28	16	134	90		50	50	88	0.1	2		

Heavy Metals (parts per million): **Arsenic,** 0.1 **Cadmium,** 0.0 **Nickel,** 0.8 **Chromium,** 0.6 **Lead,** 1.9 **Selenium,** 0.0

Report Abbreviations

Ac	exchangeable acidity
B	boron
BS%	% CEC occupied by basic cations
Ca%	% CEC occupied by calcium
CEC	cation exchange capacity
Cu-I	copper index
ESP	exchangeable sodium percent
HM%	percent humic matter
K-I	potassium index
K_2O	potash
Mg%	% CEC occupied by magnesium
MIN	mineral soil class
Mn	manganese
Mn-AI1	Mn-availability index for crop 1
Mn-AI2	Mn-availability index for crop 2
Mn-I	manganese index
M-O	mineral-organic soil class
N	nitrogen
Na	sodium
NO_3-N	nitrate nitrogen
ORG	organic soil class
pH	current soil pH
P-I	phosphorus index
P_2O_5	phosphate
S-I	sulfur index
SS-I	soluble salt index
W/V	weight per volume
Zn-AI	zinc availability index
Zn-I	zinc index

APPENDIX B- Additional Photos

Entrance to 5500 NC 126

Existing Non-Engineered Access Road

Evidence of Existing Trail

APPENDIX C – County Outdoor Shooting Range Ordinance

Section 1116.02 General Requirements When allowed, shooting ranges shall be subject to the following requirements:

1. The use of firearms shall be limited to the hours between sunrise and sunset or as determined by the Board of Adjustment through the conditional use process.
2. Theusemustnotbelocatedwithin1,350 feet of any residence. However, the residence of the owner may be located within 1,350 feet of the shooting range.
3. A development plan shall identify the Safety Fan for each firing range. The Safety Fan shall include the area necessary to contain all projectiles, including direct fire and ricochet. The Safety Fan configuration shall be based upon qualified expert documentation regarding the trajectory of the bullet and the design effectiveness of berms or other safety barriers to contain projectiles to the Safety Fan.
4. The firing range, including the entire Safety Fan, shall be enclosed with a six foot (6') high non-climbable fence to prevent unauthorized entry into the area.
5. The firing range must meet all applicable State and Federal regulations.

Section 1116.03 Site Plan Requirements

In addition to any other information required by Article XIII of this Ordinance, the site plan shall include the following information:1. Complete layout of each range, including shooting stations or firing lines, target areas, safety fans, backstops, berms and baffles; 2. Setbackof1,350 feet from any residence.

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 Lpeak 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.

15 January 2015

Environmental Analysis, Environmental Assessment, and Study of Noise Attenuation at the Proposed Wolf Pit Creek Rd, Shooting Range Site, Pisgah Game Land, Burke County, North Carolina

Commissioned by: North Carolina Wildlife Resources Commission
Division of Engineering and Lands Management
1720 Mail Service Center
Raleigh, NC 27699

Composed by:
Little Environments PLLC
16 West Martin St., Floor5, Suite 7.
Raleigh, NC, 27529,USA
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15 pages

Introduction

As part of an initiative to provide safe shooting ranges available to the public, the North Carolina Wildlife Resources Commission (NCWRC) has commenced plans to build a shooting range located on the existing Pisgah Game Land, just off of Wolf Pit Creek Rd., south of Linville, NC in Burke County. The shooting range has been designed for fixed target shooting by rifles, handguns and the occasional shotgun. The site will serve as an area for hunter education, public practice shooting, sighting in before hunts on the game lands, and general shooting. A previous sound study was carried out titled *"Sound Study Report, Proposed Shooting Range Burke County, North Carolina; Prepared for North Carolina Wildlife Resource Commission, Division of Engineering and Land Management, Creedmoor, North Carolina, October 8 2013"*. In addition to this study, the evaluation of two sound attenuation technologies was carried out at this location. This information is available in a separate report titled "*Evaluation of Two Potential Attenuation Technologies for Potential Application at the North Carolina Wildlife Resources Commission Proposed Shooting Range on Wolf Pit Creek Rd, Pisgah Game Land, Burke County, North Carolina."* The data for this report was collected by Shield Engineering Inc, in the presence of a Little Environments PLLC representative and staff of the NCWRC. The results of this report determine that further sound reduction could be achieved; however the current attenuation of sound by the natural winter environment is sufficient. The NCWRC may later decide to implement the technologies as a precautionary matter or in anticipation and respect of future developments.

Background

After community consultation with local community stakeholders, concerns still existed in regards to the future presence of a shooting range on the Pisgah game land. For this reason, an additional study was commissioned under the management of Little Environments PLLC. Similar methods to the previous sound study were implemented in the collection of the data, however the sound study was carried out later in the year to address conditions where no foliage would exist on trees. The trial was completed on the 15th of December 2014. Locations of sound monitors or test locations were also adjusted to comprehensively address concerns with potential nuisance to lake users, test locations were adjusted to evaluate the particular selected site, and revised test locations included the selected site so that direct, point to point, sound attenuation could be evaluated. The descriptions of the test locations are provided in table 1 and a map of the locations is provided in appendix A. The purpose of this report is to alleviate any concerns with the future development of

the shooting range at this site. The following data, environmental sound analysis, and conclusions address these concerns.

Table 1. Descriptions of Various Locations

Location Number	Location Description	Potential Location Concern
1	Immediately Adjacent Future Shooting Range	Data used for control to determine dissipation and attenuation of Noise
2	Approximately 1.5 Miles Up Wolf Pit Creek Rd	Examined for concern in impacting amenity in Linville Gorge and Adjacent Areas
3	Approximately 0.8 miles to the east at the Intersection of NC 126 Hwy and NC 1254	Existing Residence in the area
4	1.4 miles due west, Adjacent Fonta Flora Rd	Residences Located in the area and potential for future developments
5	Approximately 1.5 miles S-SE on the waterfront of the Lake	Site examined as an indicator for sound impacts affecting recreational lake users as well as proximity to an eagle's nest.

Data

Shield Engineering Inc collected the following data on site, in the presence of a Little Environments PLLC representative, and accompanying NCWRC commission staff. Similar methods were implemented to the previous shooting study conducted in the vicinity of this site. The guns that were used for testing at the site were (1) a .30-06 Rifle, (2) a NCWRC issue AR-15 rifle, and (3) a P226 (0.357 calibre) handgun. Photos of these firearms are provided in accompanying appendix. The predominate Lpeak for all of these guns, at ~35' from muzzle was 130 decibels (dBA). Figure 1, below is the sound measured at the site of trial, 35' offset from the discharged weapon. Figures 2, 3, 4, and 5 display continuous measured sound (Lpeak) at subsequent locations of concern. Figure 6 is a photo demonstrating the lack of foliage or leaves on the trees during this time of year.

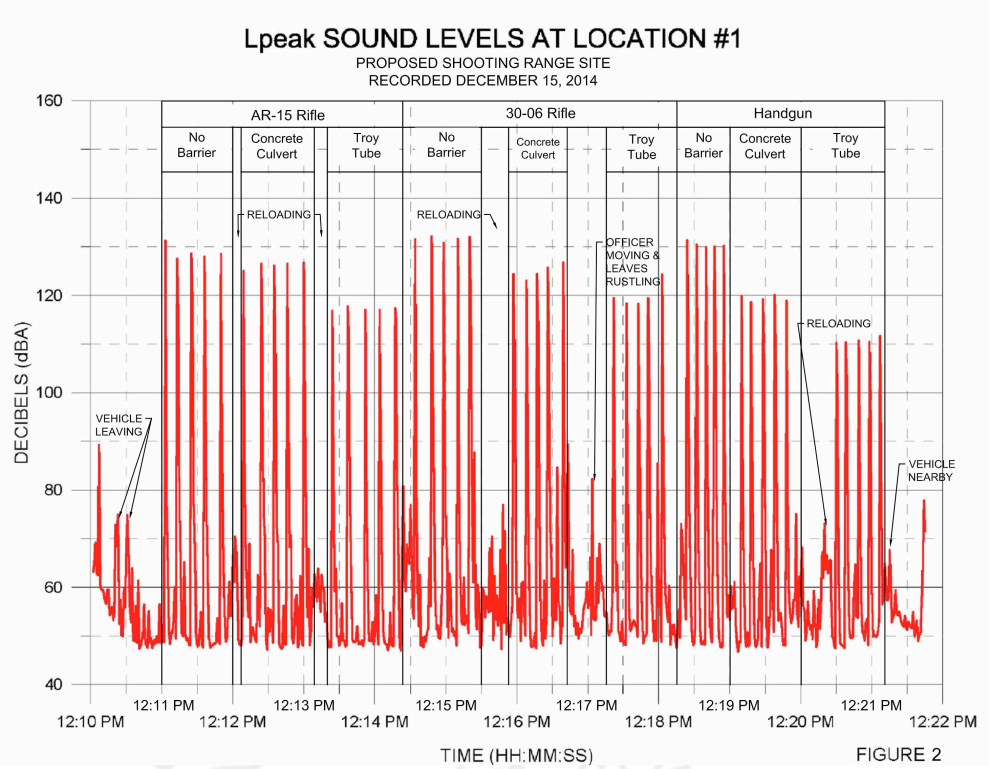


Figure 1. Readings Immediately Adjacent Future Shooting Range

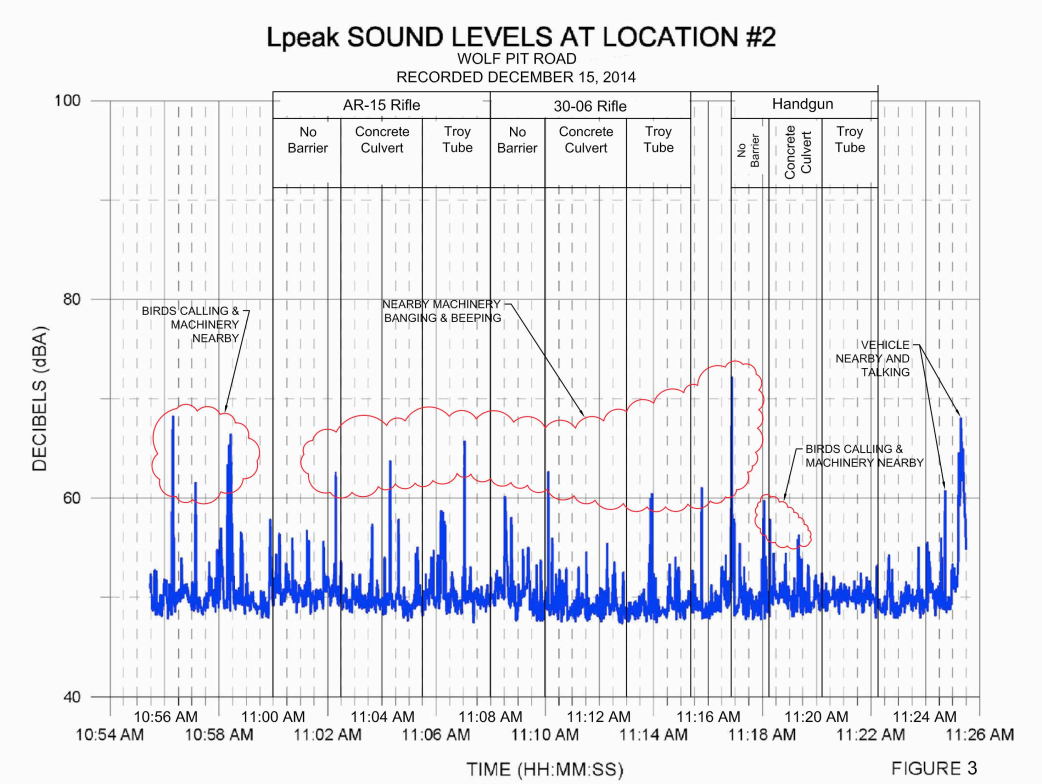


Figure 2. Readings Approximately 1.5 Miles Up Wolf Pit Creek Rd

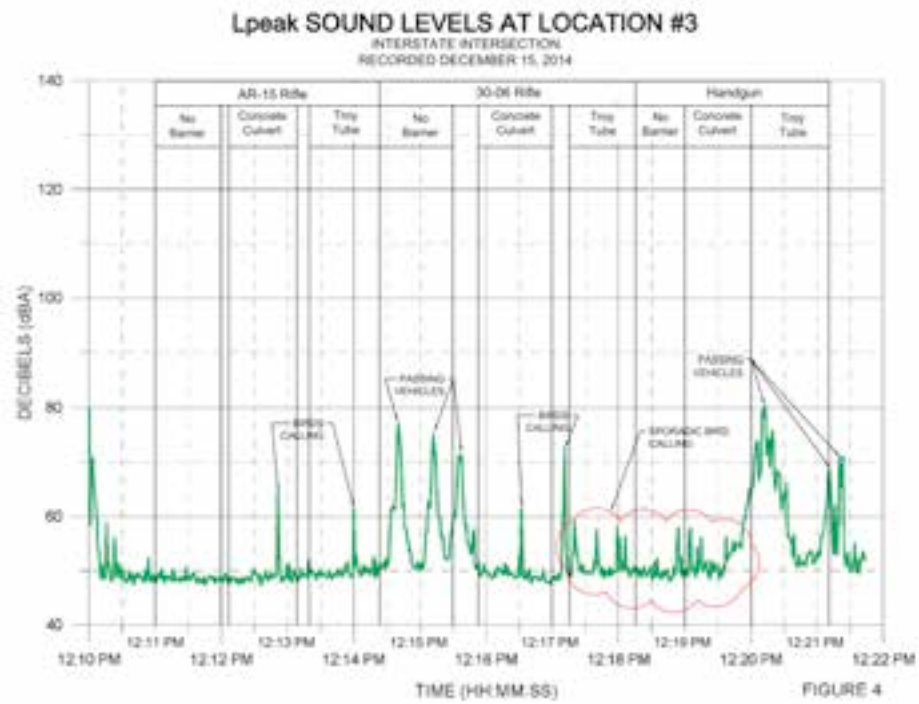


Figure 3. Readings Approximately 0.8 miles to the east at the Intersection of NC 126 Hwy and NC1254

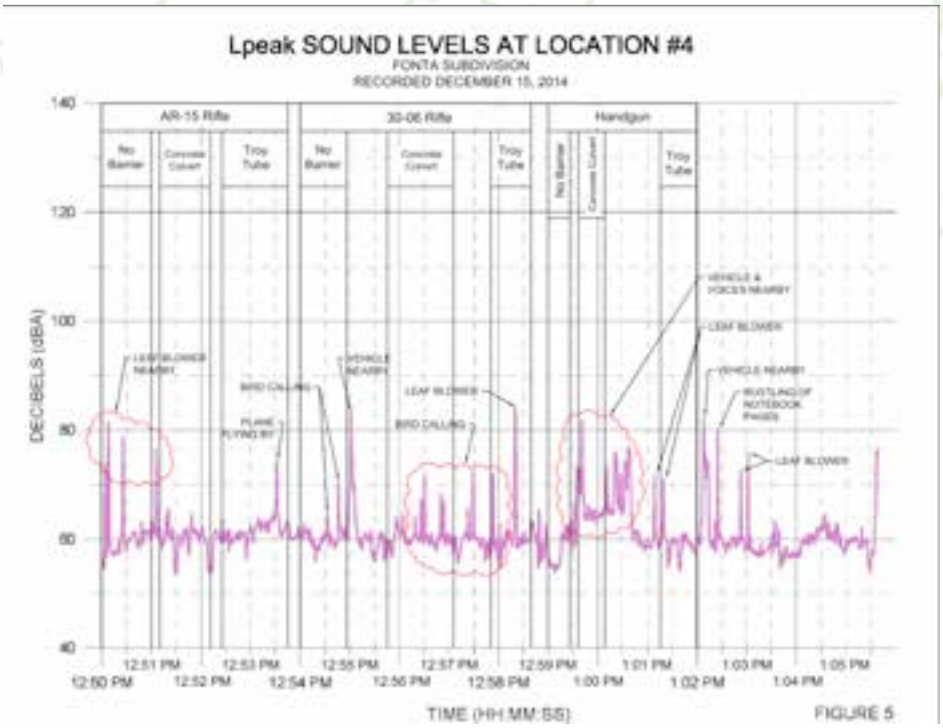


Figure 4. Readings 1.4 miles due west, Adjacent Fonta Flora Rd

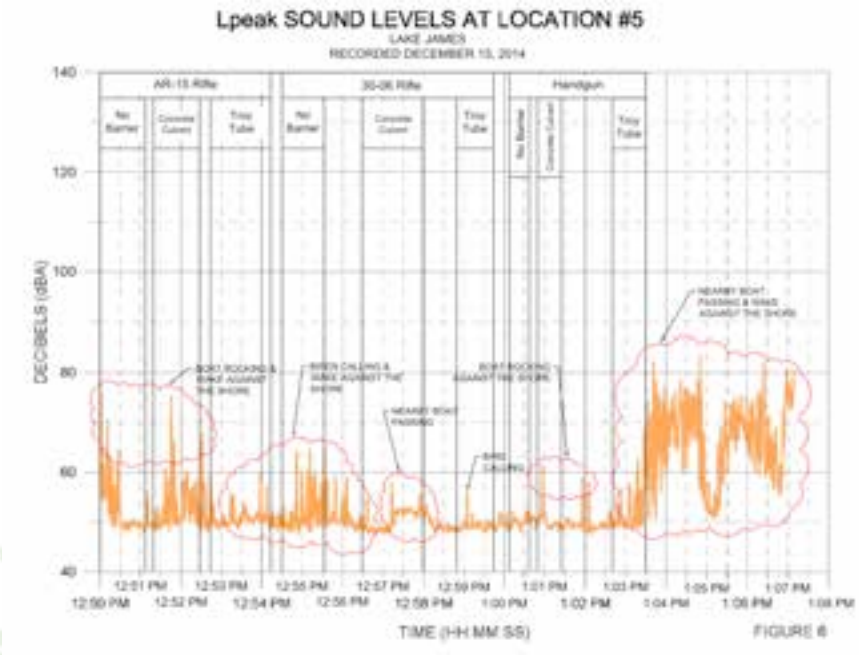


Figure 5. Readings Approximately 1.5 miles S-SE on the waterfront of the Lake

Figure 6. Photo Demonstrating State of Vegetative Growth at Time of Gunshot Sounding Trials

Environmental Sound Analysis

The following is an environmental sound analysis of the results of the data collected on site on the 15th December, 2014.

Peak Background Noise Readings at Each Location

After data was analysed at each site, the maximum Lpeak, or most intense noises experienced, were from sources, not associated with the proposed shooting range, in the immediate vicinity of the tested location. A table of these noises are provided in appendix B. These noises are relevant for environmental comparison, however to be scientifically specific, the attenuation of gun shot noise energy from the source needs to be analysed. Considering that (1) the monitored gunshots were taken in specific and close intervals, as can be observed in location 1 sound collection data, and (2) the gunshot was not heard at each location by the observing technicians, it can only be deducted that either (a) the gunshot noise energy was dissipated before it travelled from the muzzle burst to the measured location or that (b) the noise energy was indiscernible or mixed in with background noise. The background noise at each location is the baseline noise readings shown in the figures above and the on-going lower limit of experienced noise on site that was indiscernible from other noises. Exact gunshot interval information is provided in tabular form in appendix C. The following table 2 includes the approximate background noise levels for each location. For each of these sites the noise from the gunshots was attenuated to a level at or below background noise levels.

Table 2. Attenuation of Rifle Blast Noise over Distance into Background Noise

Peak Reading at Proposed Shooting Range		
Location 1 Non-Dampened Rifle and Handgun Lpeak, 35' from muzzle for dissipation consideration:		130dBA
Background Readings at Sites of Concern		
Location/Distance from Muzzle	Background Noise Level	Attenuation from Rifle Blast to background Noise
Location 1/35'	55dBA	N/A- Provided for
Location 2/1.5 miles	50-53dBA	100%
Location 3/0.8 miles	50dBA	100%
Location 4/1.4 miles	60 dBA	100%
Location 5/1.5 miles	50-55 dBA	100%

Relation to Previous Sound Study by Shield Engineering

The data collected during this field study corresponds with the data collected during the previous sound study by Shield Engineering Inc. The previous study found the following:

1. "Overall the maximum Lpeak sound levels created by shooting of the three different types of weapons at the two separate shooting sites are indistinguishable from the overall peak sound levels recorded." and;

2. "In some instances these extraneous sounds masked the sound of the weapons from either of the two shooting sites or the extraneous sounds were either just as loud as, or louder, than the sound resulting from the weapon shooting at both sites."

There were slight variations in the methods implemented for discharging firearms. On the first study by Shield Engineering Inc on the 14th of August 2013, 20 rounds were dispersed over a 3-minute interval. This is approximately one shot, every 9 seconds, where as the discharges on 15 December 2014 were approximately every 30 seconds. Considering that the baseline background noise levels were extremely similar, and 9 seconds is sufficient time to separate shot noises so they do not have cumulative affects, this slight deviation in methods is insignificant and has no bearing on the outcome or findings.

Overall the results of the previous sound study are congruent with this study and demonstrate sufficient sound attenuation from the point of creation to the examined sites or point-to-point.

Background Science

90 to 95 dBA is classified as a disturbing sound level as reported by Shield Engineering Inc.. The human ear is designed to detect pressure changes in the air. Sound is effectively a slight pressure change that occurs when sound impacts the ear or passes by the ear. Decibels are a unit measurement in which sound can be easily measured on a logarithmic scale (Hansen 2000). As sound travels at the Linville site from the area of discharge to the site of measurement, pressure intensity is primarily dissipated by (1) air in the path of the travel, (2) impacting tress or grass or topology, and (3) redirection upwards. Sound pressure can be abated by anywhere from 0.03 to 0.20 dBA per meter (Hanson,2000) as sound travels. Considering these rates, and also that the location site projects sound upwards, being in a small ravine, this scientific analysis justifies complete attenuation of gun shot sound to the examined sites. Calculations show an average environmental attenuation capacity of the existing environment of approximately 245 dBA which is enough to completely dissipate the sound beyond human hearing capability.

Conclusions

The following conclusions are in regard to the Sound Study and environmental analysis carried out on 15th December 2014 at the proposed future shooting range on Wolf Pit Creek Rd:

1. Sound was sufficiently attenuated to no more than background noise levels at all sites tested.
2. Considering the measured real time attenuation of the discharged firearm noise and the supporting background science, no excess nuisance noise or disturbing noise is expected at the tested locations after completion and opening of the shooting range.
3. The measured background noise levels are not expected to exceed the EPA yearly day-night standard of 55dBA.

Joseph Little PE
Managing Director
Little Environments PLLC
Level 5, Suite 7, 16 West Martin St
Raleigh, NC, 27529

References

Hansen, S. 2000 "Sound Attenuation Techniques and Technology" Policy track: Environmental Issues, Hansen Consulting, State College, Pennsylvania. *Fourth National Shooting Range Symposium* p118-122

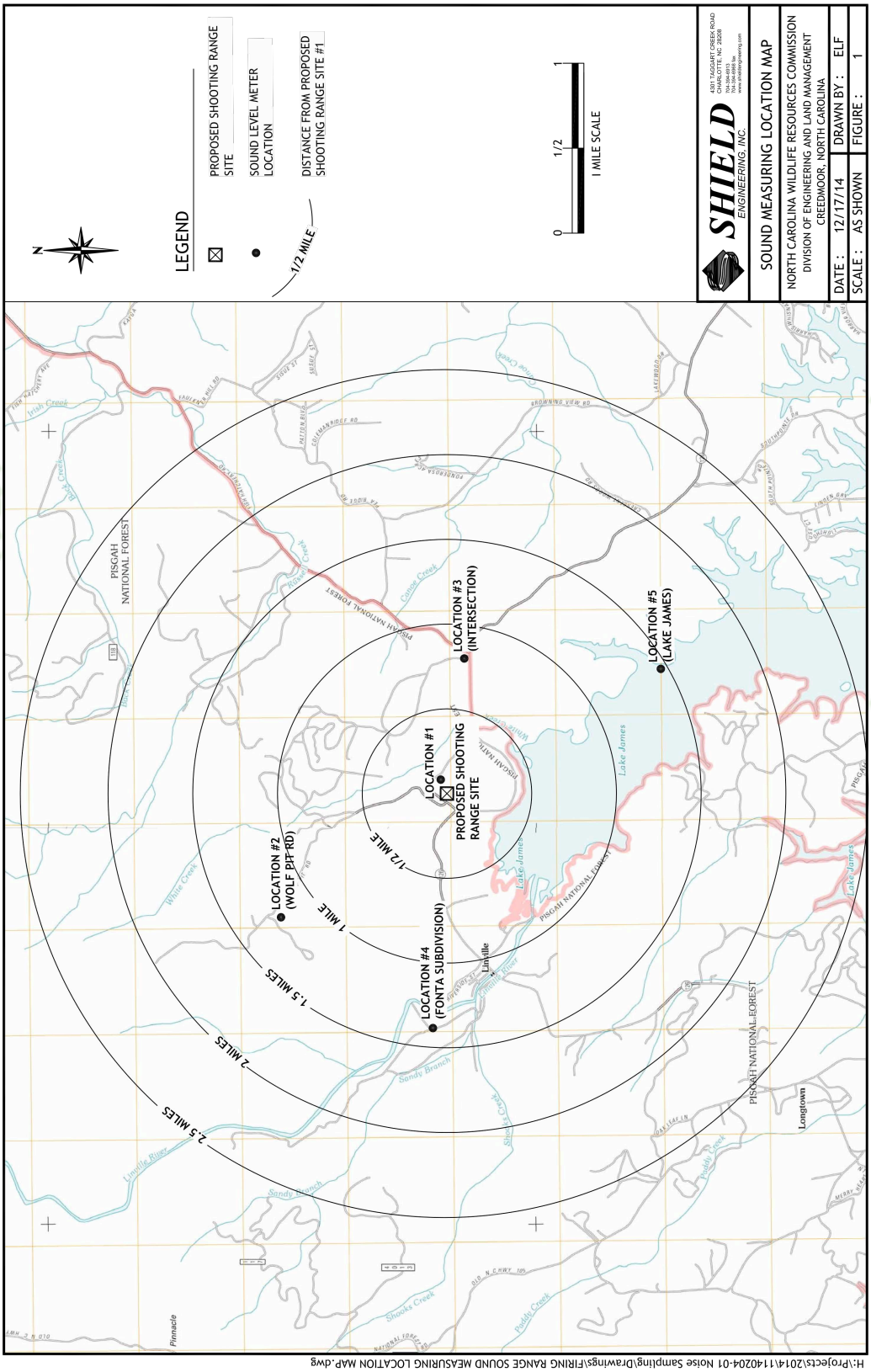
"Sound Study Report, Proposed Shooting Range Burke County, North Carolina; Prepared for North Carolina Wildlife Resource Commission, Division of Engineering and Land Management, Creedmoor, North Carolina, October 8 2013". Shield Engineering Inc.

"*Evaluation of Two Potential Attenuation Technologies for Potential Application at the North Carolina Wildlife Resources Commission Proposed Shooting Range on Wolf Pit Creek Rd, Pisgah Game Land, Burke County, North Carolina."* Little Environments PLLC

Notes

1. This report is an environmental sound study and not a finite sound model.
2. This report is based on current conditions. Little Environments PLLC cannot account for, or predict change in land use or a drastically altered environment.
3. This report acknowledges that the site will not be open before dawn or after dusk.

Appendix A- Location Map



Appendix B- Additional Data Provided by Shield Engineering Inc.

TABLE 1
AVERAGE (Lpeak) SOUND LEVEL (Decibels) AT MEASURING LOCATIONS
PISGAH NATIONAL FOREST
BURKE COUNTY, NC

	SOUND METER LOCATION (see Figure 1)				
	Location #1	Location #2	Location #3	Location #4	Location #5
Average Lpeak for Period of Record (dBA)	62.5	50.6	53.3	60.9	54.2
Distance from Proposed Shooting Range Site (miles)	0.00	1.20	0.80	1.40	1.45
Max Lpeak (dBA)	132.1	72.1	80.3	84.0	83.5
Time of Max Lpeak	12:14:48 PM	11:16:53 PM	12:20:12 PM	12:58:20 PM	1:04:50 PM
Cause of Max Lpeak	30-06 Rifle No Barrier	Nearby Machinery Banging & Beeping	Passing Car	Leaf Blower	Waves and/or Passing Boat

TABLE 2
TYPICAL SOUND LEVELS (Decibels) FOR COMMON SOUND SOURCES
PISGAH NATIONAL FOREST
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
Level at which Sustained Exposure may result in Hearing Loss	*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 C- Interval Shooting Data for Shooting Trials on Wolf Pit Creek Rd, Pisgah Game Land, Burke County, NC., Recorded by Little Environments PLLC

Sound Reduction and Attenuation Study, Pisgah Game Land, off of Wolf Pit Creek Rd.
Data from NCWRC Shooting Sessions
Recorded by J. Little PE, Little Environments PLLC, 15 December 2014

SESSION 1
Shortoff Mountain Session
AR 15 Sub-Session

Free Shoot

TIME START	TIME FINISH	No. Shots
11:00:00	11:02:30	4

Conc. Culvert

TIME START	TIME FINISH	No. Shots
11:02:30	11:05:30	5

Troy Tube

TIME START	TIME FINISH	No. Shots
11:05:30	11:08:00	5

30 Alt. 6

Free Shoot

TIME START	TIME FINISH	No. Shots
11:08:00	11:10:00	3

Conc. Culvert

TIME START	TIME FINISH	No. Shots
11:10:00	11:13:00	3

Troy Tube

TIME START	TIME FINISH	No. Shots
11:13:00	11:15:20	4

Hand Gun

Free Shoot

TIME START	TIME FINISH	No. Shots
11:16:51	11:18:09	5

Conc. Culvert

TIME START	TIME FINISH	No. Shots
11:08:09	11:20:11	5

Troy Tube

TIME START	TIME FINISH	No. Shots
11:20:11	11:22:18	6

SESSION 2

Residence to East and Immediately Adjacent Site

AR 15 Sub-Session

Free Shoot

TIME START	TIME FINISH	No. Shots
12:11:00	12:12:00	5

Conc. Culvert

TIME START	TIME FINISH	No. Shots
12:12:08	12:13:10	5

Troy Tube

TIME START	TIME FINISH	No. Shots
12:13:31	12:14:23	5

30 Alt. 6

Free Shoot

TIME START	TIME FINISH	No. Shots
12:14:23	12:13:24	5

Conc. Culvert

TIME START	TIME FINISH	No. Shots
12:16:00	12:16:59	5

Troy Tube

TIME START	TIME FINISH	No. Shots
12:17:17	12:18:25	5

Hand Gun

Free Shoot

TIME START	TIME FINISH	No. Shots
12:18:25	12:18:55	5

Conc. Culvert

TIME START	TIME FINISH	No. Shots
12:18:55	12:20:04	5

Troy Tube

TIME START	TIME FINISH	No. Shots
12:20:04	12:21:11	6

SESSION 3

Flora Fontana and Cross Lake Location

AR 15 Sub-Session

Free Shoot

TIME START	TIME FINISH	No. Shots
12:50:00	12:51:01	5

Conc. Culvert

TIME START	TIME FINISH	No. Shots
12:51:10	12:52:09	5

Troy Tube

TIME START	TIME FINISH	No. Shots
12:52:27	12:53:42	5

30 Alt. 6

Free Shoot

TIME START	TIME FINISH	No. Shots
12:54:02	12:54:52	5

Conc. Culvert

TIME START	TIME FINISH	No. Shots
12:55:47	12:57:05	5

Troy Tube

TIME START	TIME FINISH	No. Shots
12:57:48	12:58:36	5

Hand Gun

Free Shoot

TIME START	TIME FINISH	No. Shots
12:59:00	12:59:25	5

Conc. Culvert

TIME START	TIME FINISH	No. Shots
12:59:37	13:00:07	5

Troy Tube

TIME START	TIME FINISH	No. Shots
13:01:15	13:01:59	5

Appendix D- Additional Photos

7, January 2015

Evaluation of Two Potential Noise Attenuation Technologies for Application at the North Carolina Wildlife Resources Commission Proposed Shooting Range on Wolf Pit Creek Rd, Pisgah Game Land, Burke County, North Carolina

Commissioned by: North Carolina Wildlife Resources Commission
Division of Engineering and Lands Management
1720 Mail Service Center
Raleigh, NC 27699

Composed by:
Little Environments PLLC
16 West Martin St., Floor5, Suite 7.
Raleigh, NC, 27529,USA
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pages

Introduction and Background

As part of an initiative to provide safe and environmentally sound public shooting ranges in North Carolina, the North Carolina Wildlife Resource Commission (NCWRC) engaged Little Environments PLLC to research and evaluate potential sound reduction technologies that could be applied at existing and future outdoor shooting ranges on NCWRC game lands. Sound reduction technologies and products are abundant in supply for industrial buildings, indoor shooting ranges, and for highway noise abatement. Sound reduction technologies or products for outdoor shooting ranges were however found to be scarce in the American market. Most outdoor shooting technologies are implemented with site-specific design in the United States from source materials. Due to denser population in overseas countries, such as European Countries, it was suspected and confirmed that this problem and solution had been experienced before. Exact suppliers of modulare sound reduction devices were difficult to locate and make contact, however applied concepts were found in message boards and on-line blog posts in the form of pictures. Based on this information, and working with a US based sound reduction technology company, Troy Acoustics, a prototype item sound reduction tube was manufactured and then field trialled at the future Wolf Pit Creek Rd Shooting Range on the NCWRC Pisgah game land, in Burke County, North Carolina. The trial included a series of gun shot sounding trials including (i) a non-dampened controlled discharge of firearms, (ii) discharge of firearms through a 24', 2' diameter concrete culvert section, and (iii) discharge of firearms through a 8' length, 2' x 1.5' open ended rectangular prism, panelled with Troyboard.

Background Research and Technical Discussion

Preliminary research was carried out prior to executing the site trials with the sound dampening appurtenances that involved contacting supplies and reviewing literature. Critical factors where investigated and considered such as direction of sound projection (Maher 2010), type of firearm used, initial sound energy attenuation at point of discharge versus offset from discharge, mobility of device or material, durability of product, projectile shockwave and muzzle blast (Hanson 2000), and cost. Sound propagation can occur in different directions with the loudest direction typically being in front of the discharge. That also being said, sound typically reduces by 6 dB, every time the distance travelled is doubled from its initial source of creation (Hanson, 2000). Under this assumption, the more a sound is initially dissipated at the source, the quieter it will be after if travels a certain distance. Multiple sources indicated an at muzzle discharge loudness of around 150 to 160 db with the majority of source reporting around 150 dB. Shotguns were typically reported as

quieter than rifle as compressed air is allowed to escape more uniformly and less instantaneously. The mechanism that creates most of the radial projected noise is the muzzle blast or expanding air escaping the barrel. The cost of the Troy Acoustic board was around $8.00 per square foot. Concrete culverts can cost around $33..00 to $45.00 per linear foot. An alternative to implementing a tube is to create sound dampened a booth for shooting, that the entire shooter sits in. Another option is to directly outfit existing structures with sound reducing board. Outfitting an existing structure can result in excess loads beyond the initial design and can resultantly be more expensive. This was not considered in this trial due to existing range designs. An example is provided in appendix D. Also included in appendix D, is an example of a drape material that can be used to dampen sound and still allow access.

Data

The following data is from the initial dampening trial at the Wolf Pit Creek Rd proposed site. The guns that were used for testing at the site were (1) a .30-06 Rifle, (2) a NCWRC issue AR-15 rifle, and (3) a P226 (0.357 calibre) handgun. Figure 1 is a graph of the discharge data for the various gun types. Tabular firing details are provided later in appendix B for reference. The average peak readings are provided in tabular form in table 1 for each type of firearm and each type of dampening device. Table 2 provides the percent reduction on each type of firearm applied with each dampening device. The Troy Acoustics tube typically performed twice as efficiently as the concrete culvert in regards to decibel rating reduction. An examination of the data is elaborated upon further in the analysis section.

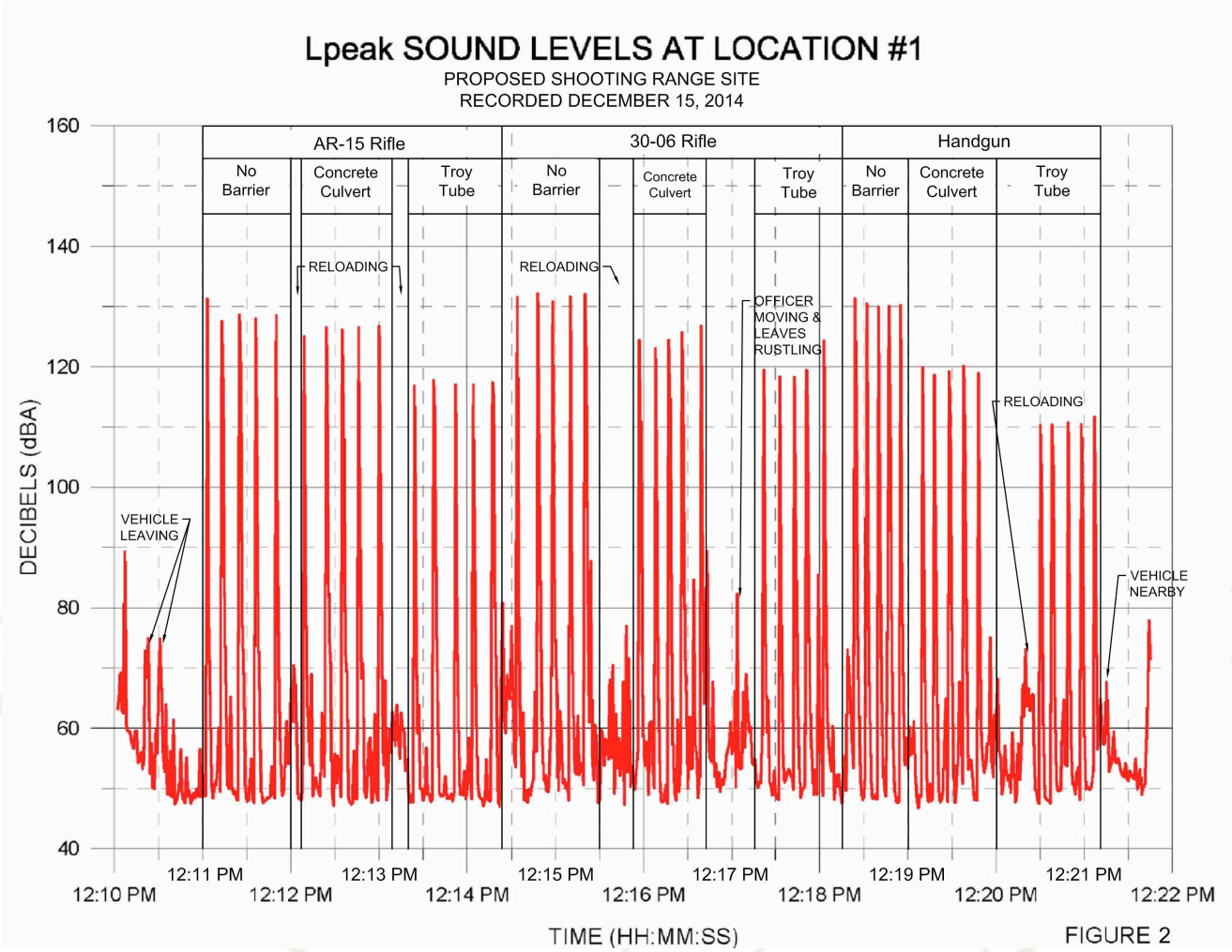


Figure 1. Readings Immediately Adjacent Future Shooting Range

Table 1. Sound Readings 35' from Trial site

Firearm Used	Peak Control level	Concrete Culvert Dampened	Acoustical Tube Dampened
.30-06 Rifle	132 dBA	125 dBA	118 dBA
AR-15 Rifle	129 dBA	126 dBA	119 dBA
P 226 Handgun	130 dBA	120 dBA	110 dBA

Table 2. Percent Reduction in Noise at Site of Discharge

Firearm Used	Percent Dampened or Attenuated by Concrete Culvert	Percent Dampened or Attenuated by Troy Acoustics Lined Tube
.30-06 Rifle	5%	11%
AR-15 Rifle	2%	8%
P 226 Handgun	8%	15%
Average	***5%***	***11%***

Analysis

Figure 2, below, shows the Troy Acoustics prototype trial tube(TAPTT) adjacent the 24' of concrete culvert. The TAPTT is approximately the weight of one of the concrete culvert sections and 8' in length. The TAPTT has an overall reduced footprint. Observations by witnessing members on site experienced a better and significantly noticeable reduction in sound from the TAPTT trial. This was noticed behind the shooter and to the side of the tube. Personnel on site experienced only a slight reduction in sound when shots were discharged through the concrete culvert. To contrast with the TAPTT, the longer concrete culvert including a reverberating sound that was more drawn out. The sound reduction with the concrete culvert was less noticeable when standing directly behind the prone shooter. This coincides with the data above and a physical observation of the materials the tubes are constructed or manufactured from. Concrete is a solid rigid material with few voids that reflect sound quickly with little attenuation or sound wave adsorption. The attenuation that did occur with the concrete culverts is suspected to be from continued reverberation in the culvert, until the sound escapes from the ends.

Improved sound reduction was noticed with the handgun trials. This correlates with the ability of the user to place more of the firearm into the dampening device while discharging the firearm.

Overall the shorter, better field of view, TAPTT prototype, dampened the sound more sufficiently. This is validated through qualitative witness experience on site and recorded quantitative data.

Figure 2. Layout of Concrete Culvert and Troy Acoustics Prototype

Conclusions and Recommendations

The following conclusions were made in regards to the application of the trial technologies at the Wolf Pit Creek Rd site in Burke County.

1. On properties with limited area or close to a property line, application of these technologies can allow the site to be constructed half the existing acceptable distance to the site while still meeting regulatory requirements.
2. The product manufactured from sound reducing and sound absorbing board, absorbed about twice the energy as the concrete culverts.
3. The concrete culverts were effective at reducing the noise from the muzzle blast by about 10 decibels while the Troyacoustics prototype tube was effective at reducing the noise from the muzzle blast by about 20 decibels.
4. The rectangular Troyacoustics prototype tube allowed for a larger vision window, more similar to open range shooting. This was due to the reduced length and larger window of vision when compared to the 24' length circular concrete culvert.

These approaches are applicable to this site and can be applied at other sites to help address noise issues. It is recommended that if these approaches are to be applied on other sites that durability, patron use, cost, shooter experience, and other alternatives also be considered on a site-specific basis.

From the Director

Thank you to the NCWRC for the opportunity to provide this service. We encourage anyone to contact us with Questions.

Joseph Little PE
Managing Director
Little Environments PLLC
Level 5, Suite 7, 16 West Martin St
Raleigh, NC, 27529

References

Hansen, S. 2000 "Sound Attenuation Techniques and Technology" Policy track: Environmental Issues, Hansen Consulting, State College, Pennsylvania. *Fourth National Shooting Range Symposium* p118-122

Maher R and Shaw S 2010 "Directional Aspects of Forensic Gunshot Recordings" AES 39th International Conference, Hillerod, Denmark 2010 June 17-19th

Notes

1. This study was composed with data duly taken for additional use in the report titled "Environmental Analysis, Environmental Assessment, and Sound Study of Noise Attenuation at the Proposed Wolf Pit Creek Rd, Shooting Range Site, Pisgah Game Land, Burke County, North Carolina."
2. This trial does not evaluate the safety of the prototype shooting devices certify safe use, as population trials or analysis have not been carried out.
3. This document is not intended to be used as a design guideline or for certification of application on other sites without the approval or review by Little Environments PLLC. Please contact info@littleenvironments.com with questions.

Appendix A- Troyboard, Board Only, Test Data

RIVERBANK ACOUSTICAL LABORATORIES

1512 S. BATAVIA AVENUE
GENEVA, ILLINOIS 60134

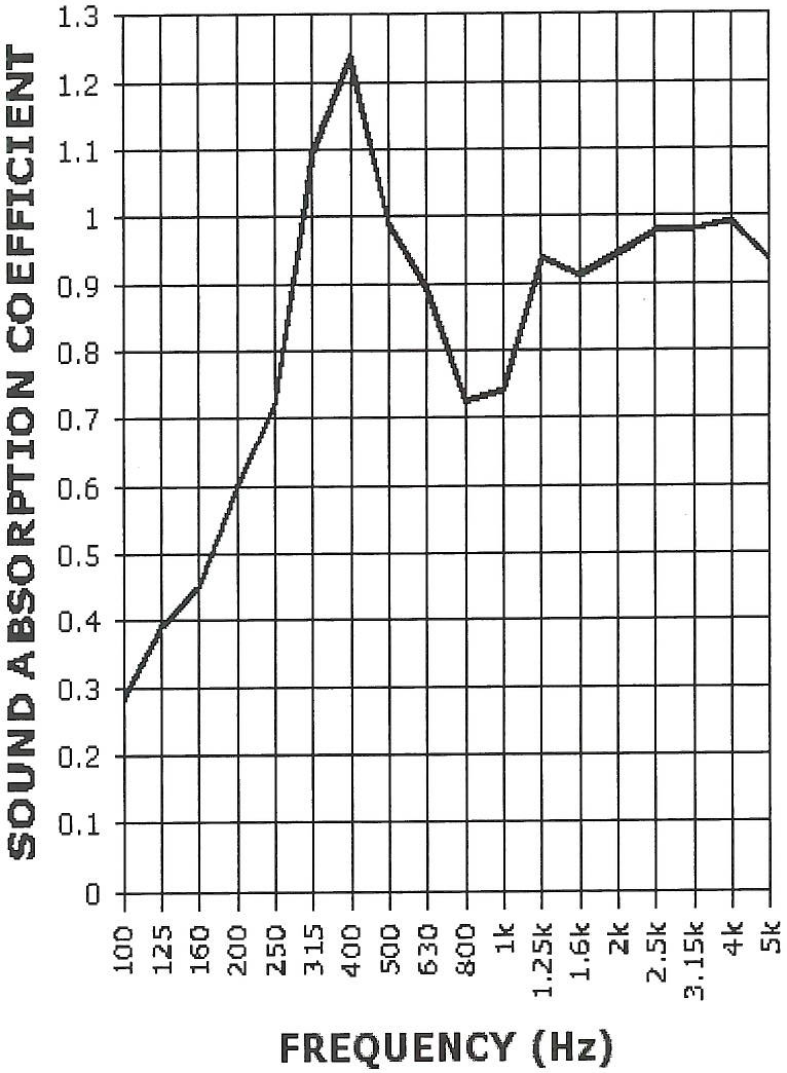
630/232-0104
FOUNDED 1918 BY
WALLACE CLEMENT SABINE

Alion Science and Technology

Page 4 of 4

TEST REPORT

SOUND ABSORPTION REPORT
RAL-A11-208a



SAA=0.90
NRC=0.85

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Appendix B- Interval Shooting Data for Shooting Trials on Wolf Pit Creek Rd, Pisgah Game Land, Burke County, NC., Recorded by Little Environments PLLC

Sound Reduction and Attenuation Study, Pisgah Game Land, off of Wolf Pit Creek Rd.
Data from NCWRC Shooting Sessions
Recorded by J. Little PE, Little Environments PLLC, 15 December 2014

SESSION 1
Shortoff Mountain Session
AR 15 Sub-Session

Free Shoot

TIME START	TIME FINISH	No. Shots
11:00:00	11:02:30	4

Conc. Culvert

TIME START	TIME FINISH	No. Shots
11:02:30	11:05:30	5

Troy Tube

TIME START	TIME FINISH	No. Shots
11:05:30	11:08:00	5

30 Alt. 6

Free Shoot

TIME START	TIME FINISH	No. Shots
11:08:00	11:10:00	3

Conc. Culvert

TIME START	TIME FINISH	No. Shots
11:10:00	11:13:00	3

Troy Tube

TIME START	TIME FINISH	No. Shots
11:13:00	11:15:20	4

Hand Gun

Free Shoot

TIME START	TIME FINISH	No. Shots
11:16:51	11:18:09	5

Conc. Culvert

TIME START	TIME FINISH	No. Shots
11:08:09	11:20:11	5

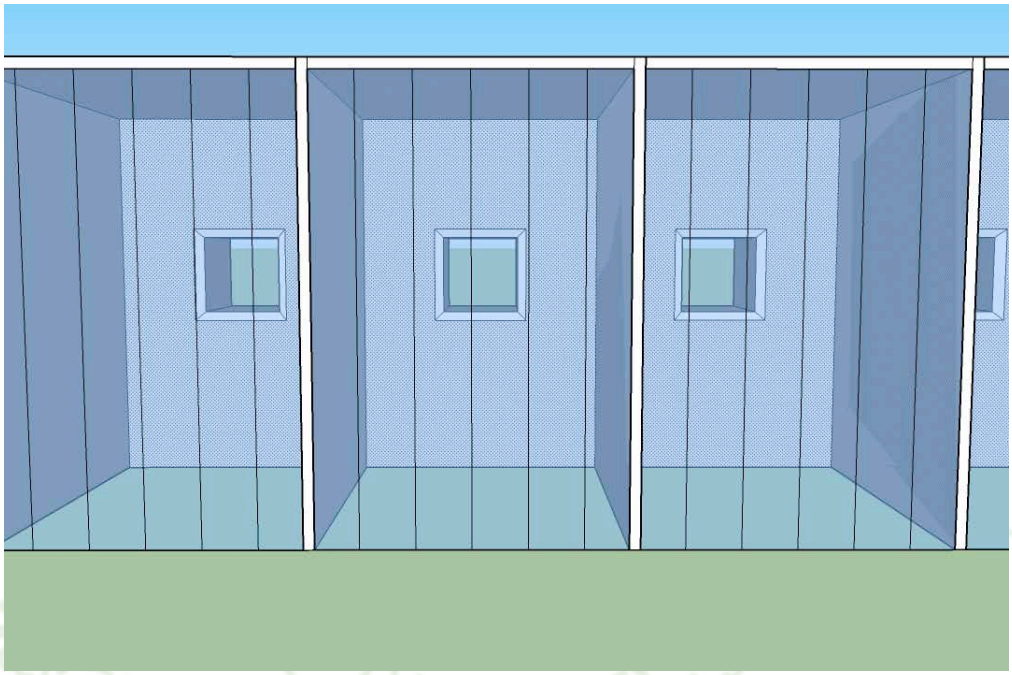
Troy Tube

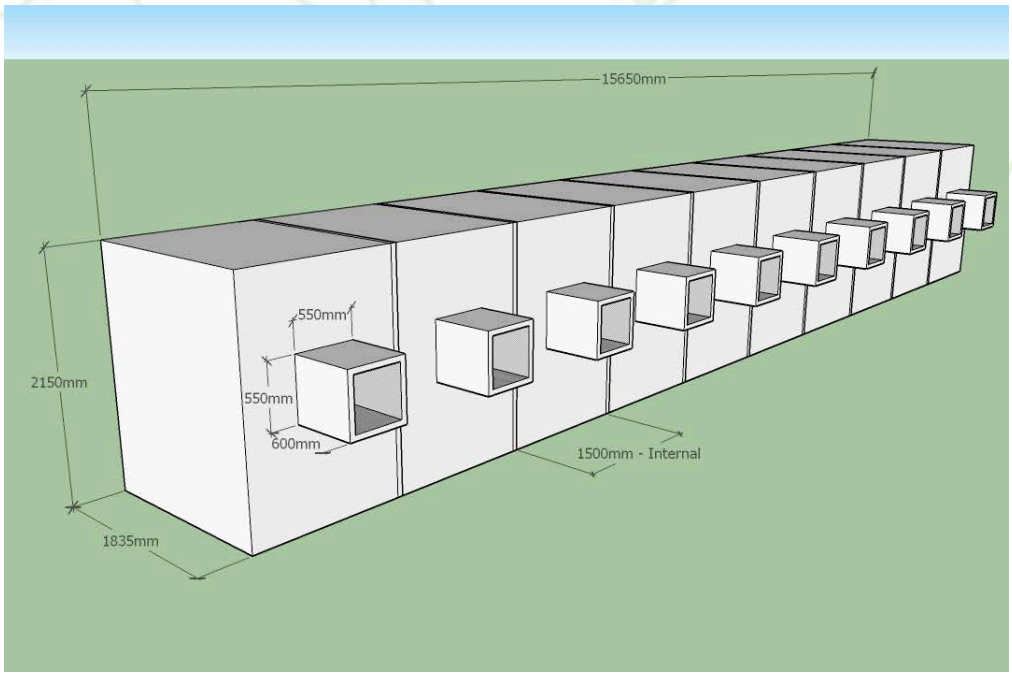
TIME START	TIME FINISH	No. Shots
11:20:11	11:22:18	6

Appendix C- Swiss Technology Concept that Served as Basis for Investigation

Photo from: **http://theswissriflesdotcommessageboard.yuku.com/reply/47672/Swiss-Schiess-Tunnel-aka-tube-range-mufflers#.VK3F-ihrUdJ**

Appendix D- Sound Booth Example with Hanging Strip Material





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