

FINAL SAFETY EVALUATION

Ranges in the Vicinity of the Tri Mountain State Park, the George Washington Trail, the Blue Trail, and the Homes in the Vicinity of Tri Mountain Road

BY

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FOR

The Town of Durham, Connecticut

EVALUATION PERIOD

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Executive Summary

Golden, Weise and Associates, LLC (hereinafter referred to as GWA) was contracted to conduct a safety review and assessment of the Blue Trail Range (BTR) and other ranges in the vicinity of Wallingford, Connecticut by the Town of Durham, Connecticut. GWA has conducted an extensive review of reports filed by the Department of Public Safety, topographical and satellite analysis of the neighboring ranges and areas where bullet strikes have been reported. The preponderance of the Public Safety Office reports indicates that the source of these bullet strikes might possibly be the Blue Trail Range located in Wallingford, Connecticut; and we have included data that encompasses the Blue Trail Range, a range in the vicinity of the Blue Trail Range (for purposes of this report, named Blue Trail Range North) also owned by the Blue Trail Range owner, the Tri-Mountain State Park and the area involving the homes with confirmed bullet strikes.

GWA normally conducts an on-site evaluation of a shooting range to review range operations and safety procedures in order to identify any safety or operational related issues for the range owners. We then make recommendations on how to correct, eliminate or mitigate these issues with appropriate procedures, changes in siting or physical alterations to the range. Our normal procedures include visiting the range and meeting with the owners/operators to find out what their day to day operations consist of and what types of ammunition and weapons are allowed on the range and the type of firing allowed. We use a Range Safety Checklist during the interview to determine if any areas within the ranges normal operating and safety procedures might need corrections or what enhancements would prove beneficial to the overall range complex's safety or operational procedures. GWA has requested, through the Town of Durham and the Blue Trail Range Attorney, to meet with The Blue Trail Range owners/operators but as of this writing we have not been granted permission. Although GWA was not specifically asked to evaluate Blue Trail Range North, we did determine that it too had the capacity to create a public hazard in the area of concern to the Town of Durham. We provided a technical assessment of this range as well.

This report provides information to the Town of Durham, Connecticut involving the operation of the Blue Trail Range and other local ranges which have been identified as potential escapement sources and may have potential impacts to property owners in the local area. This information is available to anyone approved by the Town of Durham, Connecticut or other entities based on State and Federal laws. The information contained in this report is based on civilian and military industry standard guidelines as delineated by the U. S. Army, U. S Marine Corps, U.S. Air Force and the National Rifle Association; hereinafter referred to as the NRA.

The information provided also includes a review of the Blue Trail Range Study conducted by Mr. Clark Vargas as requested by the Town of Durham, Connecticut.

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Executive Summary Findings and Recommendations: The information below is a summary of the findings and recommendations contained in this report:

Finding: Based on our Technical Evaluation there are two ranges which could have been the source of the errant rounds that have impacted homes and land parcels within the Tri-Mountain State Park area and were reported to and documented by the Connecticut State Police. The ranges include the Blue Trail Range and Blue Trail Range North.

Recommendation: The potential impact for escapement of rounds fired from these two ranges will continue until such times as the ranges are redesigned to achieve total containment of all rounds fired or until ammunition and weapons are restricted to those which do not escape the current controlled range boundaries. This would effectively limit both ranges to pistol firing only until full containment can be achieved. While closing these ranges is an option, it should also be understood that there is a potential drawback where uncontrolled firing may be redirected to “uncontrolled areas” such as “backyard ranges” resulting in shifting the current escapement issues to new areas.

Finding: The owners of the Blue Trail Range have made significant efforts to reduce the possibility of round escapement and the subsequent associated risks by providing strict operating standards, limiting the use of some weapon types, adding some baffling and upgrading the security of the range based on the report provided by Mr. Vargas. These efforts appear to have made some difference as there has been only one report of an errant round strike in the past nineteen months since the improvements were instituted. A follow-up visit with homeowners in the Tri Mountain Road area conducted on 6 April 2010 indicated that although there have been no additional police report; however, some residents still live in fear from the sounds of projectiles flying over their homes and projectiles striking trees. These residents also indicate feelings that portions of their homes and properties are denied them because of the threat of potential harm.

Recommendation: The improvements to the Blue Trail Range appear to have mitigated some of the round escapement issues but will not result in full containment until such time as the range is redesigned to meet the full containment standards. We have suggested some further improvements for the Blue Trail range in the Technical Evaluation Section of this report that we believe will mitigate more of the risks. These recommendations include the need for an additional evaluation of the Blue Trail Range North. We also would recommend additional baffling and the removal of the intermediate backstop on the Blue Trail Range on Range Three and Range Four. The bottom line is that the community leaders, park users and residents who reside downrange from these ranges will have to determine what level of risk they are willing to accept. Several property owners at the 6 April 2010 meeting very adamantly stated that “no risk” was the only acceptable risk.

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Guidelines, Standards and Regulations

There are published guidelines, standards, and regulations associated with the operation and use of shooting ranges. These guidelines are designed to provide range planners, owners and managers with specific operational and safety parameters for the safe and efficient operation of shooting ranges. GWA uses a combination of civilian and military regulations and guidelines to evaluate ranges that establish criteria for the proven design and operation of modern firing ranges. Specifically cited in this report are Department of The Army Pamphlet 385-63, Range Safety, dated April 10, 2003; Army Regulation 385-63/Marine Corps Order 3570.1B, Range Safety, dated May 19, 2003; United States Air Force Engineering Technical Letter 08-11, Small Arms Range Design and Construction, dated October 20, 2008; and The National Rifle Association (NRA) Source Book, A Guide to Planning and Construction, revised January 2004. GWA uses these source documents as they provide the most comprehensive information and criteria currently used by military and civilian marksmanship range planners and organizations. The military standard for the probability of hazardous escapement of live ammunition must not present a greater hazard than 1:1,000,000 (unlikely) to the public per Department of The Army Pamphlet 385-63. The outside trace of the Surface Danger Zones computed in this document indicates that 1:1,000,000 risk level. This includes the actual round of ammunition and all of its components. Additional information on determining distances required for various weapons can be obtained from the NRA Source Book in Section 1, Chapter 1, and Article 3. The probability of projectile escapement will vary in degree based upon terrain features (natural or manmade backstops), range structures (berms/bullet traps/target frame composition), and the chosen shooting activity. The military standard of 1:1,000,000 is used as the standard when developing the escapement potential for a given round of ammunition. However, none of the scientifically calculated surface danger zones (range fans) are effective unless there is someone available to enforce published range safety standards and guidelines. In fact, the NRA Source Book adds a disclaimer that states, "The Range Source Book is **NOT** a code book or certification standard, but rather a publication listing general suggestions. Each range is site specific, fact sensitive, risk driven, and needs to be considered in that light. The National Rifle Association assumes no liability for information contained herein." In fact the use of Surface Danger Zones (SDZs) was clarified by Mr. David Luke who is a member of The Range Technical Team of the NRA. Mr. Luke stated during the Third National Shooting Range Symposium in 1966 and a subsequent article that, "Backstops and side berms do not remove the requirement to include a safety fan (SDZ). A ricochet catcher, ricochet baffle or eyebrow can be installed to reduce the incidence of bullets escaping the range by sliding up the face of the backstop."

Review of the Safety Report, Study Analysis and Schematic Dated July, 2008 by Mr. Clark Vargas

A copy of Mr. Vargas' report was provided to GWA by the Town of Durham, Connecticut and a subsequent review of its contents was then conducted. The following comments are provided based on Mr. Vargas' report (hereafter, "the report").

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In paragraph one of the Executive Summary Mr. Vargas states, “Based on my professional review of the range and its rules, operations at Blue Trail Range are unlikely to have been the launching point of the bullets that have impacted residential properties of the eastern side of the Tri-Mountain area.”

1. It is not known how this conclusion was reached since the report states in several areas that there was no evaluation of the 200 yard range (Range 2 in his report) or the Dinan pistol range (Range 1). Without evaluating the 200 yard range and the pistol range it is impossible to tell if either could be responsible for the bullet strikes down range between the firing lines and areas including the impacted homes and beyond. In fact, none of the four ranges can be eliminated as a potential candidate since baffling was not completed prior to some of the alleged bullet strike incidents going back to 1996 based on police reports. Prior to any baffling of the ranges the industry standard Surface Danger Zones (SDZ) would have been the standard for determining what areas could be impacted. Please see Enclosure #1, SDZ for firing small arms, machineguns, and shotguns firing at a fixed ground target.

2. When reviewing the report we did not find a copy of the Surface Danger Zones for each of the four ranges. A Range Surface Danger Zone Diagram is one of the most important tools used in all Range Safety Inspections. It depicts the range fan for the largest caliber of ammunition and the potential danger areas. Page 1.2 of the report states, “We identified the ranges and plotted the theoretical “surface danger zone” for ranges 3 and 4, which are the ranges being evaluated.” We could not find these diagrams in the report; but again, since the 200 yard range and Dinan pistol range were not evaluated we do not believe that all of the potential sources of escapement impacts from the range were identified. It is standard policy for military and civilian ranges to ensure that no one is allowed entry into any portion of the Surface Danger Zone down range from the firing lines. The Surface Danger Zone from the Blue Trail Range from the firing lines, using standard 30.06 rifle ammunition, encompasses a large area of private and public property and extends beyond and down range from the real property owned and controlled by the Blue Trail Range. This ammunition can travel up to 3.12 miles (NRA Source Book) or the military equivalent (7.62 mm M80 Ball NATO Round) of 4,100 meters or 13,448 feet or 2.54 miles. This range (3.12 miles) is generally used during site evaluation for civilian ranges by the NRA to determine if the site is large enough to accommodate a high-power rifle range (NRA Source Book). The NRA Source Book goes on to say, “Remember that you will most likely be held responsible for the damage or injury caused from any bullet or shot that escapes the shooting range, no matter what the distance that the bullet or shot traveled.”

3. As part of the review of the report, we studied the “as-built” drawings and determined that a single baffle at the firing line is most likely not sufficient to preclude firing projectiles over the rear berm and potentially over the ridge. The NRA recommends that baffled ranges meet the “No Blue Sky” criteria. “This concept is based on a blue sky gap, meaning that baffles are setup so that the shooter, regardless of shooting position, cannot see any blue sky downrange. These fixtures may be overhead, on the ground, on top of the backstop, in the roof of a firing line cover, in the form of an elongated box or as a completely enclosed tunnel. The principle behind the design is to equip a range with baffles so that a bullet can leave the range confines, but will fall to earth within a smaller, more predictable area.” (NRA Source Book) The No Blue Sky policy is also based on a shooter firing from a fixed position at a fixed

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target position. The entire baffling system can be corrupted if the shooter and Range Safety Officer do not adhere to the established range procedures such as moving down range from the fixed firing position or the conduct of cross lane firing as examples. These baffles, in order to be effective, must stop or redirect the projectiles to the ground. Baffles that allow errant projectiles to penetrate and pass through do not provide any risk reduction downrange. “No Blue Sky” ranges are normally synonymous with “partially baffled” ranges which do not contain ricochets inside the range boundaries. The references in the report to “ballistic shadowing” are invalid if ricochets are not contained or if the baffles in place do not stop errant projectile.

Mr. Vargas had previously given a presentation at the Third National Shooting Symposium in 1996 entitled, Design Guide Criteria for Shooting Ranges. The following are excerpts from that presentation which we consider relevant to this project:

1. “There is only one overriding design criterion paramount to the design of shooting ranges and that is safety. There is an adage known by experienced range designers and range operators; a completely safe range cannot be designed. A safe range results if, and only if, it is safely operated and if the participating shooters are controlled by the rules and safety policies.” (Underline added by GWA.)

2. “The referenced range specifications and definitive drawings we will be using as examples are from Army Regulation 385-63. This publication clarifies certain requirements on ranges, reviews ballistic data, and incorporates new standardized range design. Other examples are from the National Rifle Association’s Range Source Book.” Note: These are the same guidelines and regulations used by GWA in this report.

3. “The surface danger zone to provide a safe area for one shooter to shoot is a very large area and in most urban locations would be cost prohibitive.”

4. “One of the most important criteria to control range construction cost is to select a proper site. There must be sufficient distance behind the backstop so that sound does not affect the neighbors. You don’t want neighbors to complain. Also, if a round or a ricochet gets out, it should fall within the range’s non-accessible fenced property. If you build in a populated area, your range must be totally baffled so that the range owner can demonstrate to a judge that a round cannot escape. Ranges are very expensive to construct.” (Underline added by GWA.)

It appears that some of the Surface Danger Zone mitigations provided for the Blue Trail Range by Mr. Vargas conflict with his own design criteria. There is a chance that the improvements made as a result of his work have reduced the incidences of projectiles leaving the confines of the range. We can find nothing in the report that says any of the ranges employed any baffles before his review or when bullet strikes were reported from 1996 to 2008. There was a statement in one of the police reports that one of the ranges had some baffling previously which had been removed for a shooting event and then replaced. It appears that the baffles were not used regularly until the baffles designed by Mr. Vargas were employed. There was no discussion on the type of baffles that were used, the material they were made of or to what extent the baffles covered the down range areas forward of the firing line.

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Standard Range Operations Safety Procedures

The basic principles of live fire range safety procedures are applicable to all ranges that use live ammunition. We will discuss some of the comments in Mr. Vargas' report first; and then the recognized industry standards.

On page iii of the report, it is stated in paragraph 4, "This report summarizes the safety features at the Blue Trail Range and appends the revised safety rules currently in place. The Lyman Blue Trail Range's Operational Procedures have been revised to ensure the maintenance of physical safety features and conformity with safety rules. (Underlines added by GWA). These operational procedures include procedures for identifying and stopping any safety rules violations."

The report indicates that some range procedures were "revised". Since the Vargas report does not specify if some or all of the safety rules were revised we can only assume that some safety rules or procedures were not adhered to or were not in place prior to his recommendations. Specifically the report states on Page 3-1, "In addition, without our recommendations, the Lyman Blue Trail Range instituted the following safety procedures in June and July 2008:" The report goes on to address several changes to the physical layout of the range (fences, security cameras, range safety officer house, etc.) and improved safety rules and procedures. On a positive note, each of the improvements made to the Blue Trail Range should enhance the future safe operations on these ranges if implemented and enforced at all times, and reduce potential escapement of rounds being fired on the range.

The implementation of these new measures does lead to some questions which we would normally address directly with the range owner if we had the opportunity to meet with them. One of the most important questions we would ask would be if, at any time in the past, were users allowed to fire on the range without the direct supervision of a certified Range Safety Officer? All industry standard guidelines and regulations mandate that a trained Range Safety Officer be present when all firing is conducted and that the Range Safety Officer has been trained to an established standard to enforce the written range safety procedures. Another question would address the possibility of anyone firing on the range without permission after normal operating hours or the ability to access and use the range during normal operating hours by anyone not approved by the range owner. If either situation occurred or could have occurred then there is absolutely no way to determine if anyone firing on the ranges adhered to all of the published range safety rules and regulations. In essence, anyone who had access to the range could conduct any type of firing without anyone knowing about it, and it would be impossible to state that the range rules were followed and that firing over the Tri Mountain area was not done. We ask this question because the report indicated that hidden security cameras were added to control unauthorized access and improper shooting at the range. Additionally, the report stated that the firing line positions were fenced off so that access to the firing line "is now controlled". This access issue also appears to be supported by an eye witness statement. This statement was provided by a Mr. Robert Saunderson to the State Police that involved an individual that "walked around the fence approached the firing line. He then observed the male sit down at a bench on the firing line and then fire fifteen to twenty shots." The

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individual then went back to his vehicle, secured the weapon and drove off. This incident occurred in March 2008 per the witness statement dated May 29, 2008 as identified in DPS INCIDENT NUMBER: CFS08-00143620.

We would normally have additional questions about the layout of the ranges and range safety and operational procedures prior to Mr. Vargas' visit but without being able to access the range or discuss this with the range owner they cannot be verified.

Additionally, we would be interested in identifying all physical features of the range prior to the new enhancements. It was indicated in Mr. Vargas' report that changes were made to the backstops but the report only said that the backstops were to be raised. The military and the NRA have recommended height, depth and angular surface guidance published for backstops and side berms. If the previous backstops and side berms did not meet these recommended guidelines they would be considered as a safety issue and would have added to the possibility of round escapement.

The operational and control enhancements made to the range may have contributed to the decline in the incidences of reported stray projectiles in the Tri Mountain area. Although we were not able to review all of the operating procedure (just those contained in Mr. Vargas' report were available to us) there appears to be improvements in the operational safety of the range.

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Technical Evaluation of Ranges in the Vicinity of the Tri-Mountain State Park, the George Washington Trail, the Blue Trail, and the Homes in the Vicinity of Tri-Mountain Road

Technical Executive Summary

The observations made by Mr. Charles Golden and Mr. Clifford Weise in the evaluation of reported bullet strikes in the downrange area of the Blue Trail Range indicate that a high probability of projectile escapement has occurred in the past. During the time period of December 1996 to December 2008, approximately twenty-five projectiles have been seized; two of which were attributed to ranges other than the Blue Trail Range.

Figure ES-1: Summary of Police Reports.

Report Date	Address	Report Number	Comments	Assumed BTR Rounds	Assumed Other
2008-12-12	35R Catherine Drive, Durham	800606592	Single bullet strike to barn.	1	
2008-06-01	Blue Trail Range		Range closes for approximately sixty days for Clark Vargas renovations.		
2008-05-27	241 Tri Mountain Rd, Durham	800249142	Single bullet strike, checked adjacent residence found evidence of bullet strike	1	
2008-05-27	251R Tri Mountain Rd	800249142	See above	1	
2008-05-18	Investigation of Tri Mountain State Park Area	ID-08-000994	Evidence of projectile strikes in beaten zone and trees to mountain summit. Could not exclude Blue Trail Range as possible source		
2008-04-16	35R Catherine Drive, Durham	800175657	Projectile lodged in side of home, one in roof. Two projectiles recovered.	2	
2008-03-28	265 Tri Mountain Rd, Durham	800143620	Three possible strikes, bullet retrieved from garden. Two additional projectiles retrieved from home.	3	
2007-10-18	235 Tri Mountain Rd, Durham	700430113	2 bullets recovered from holes in wall. Two additional holes discovered 8/5/2008. Projectiles recovered from the first two. One projectile recovered 08/08/2008. Two projectiles were determine to most likely have come from the New Haven Raccoon Club. Two from the direction of Blue Trail Range.	2	2
1999-08-31	46 Etzel Dr, Durham	F99-274266	Bullet through window, round found on windowsill	1	
1999-05-31	265 Tri Mountain Rd, Durham	F99-166140 and F97070995	One Projectile recovered by the State Police from a strike through a bedroom window. Three additional strikes were discovered in subsequent investigation. Two additional rounds were retrieved from the pool and a rain gutter several weeks later. By September additional rounds were discovered for a total of eight submitted into evidence.	8	
1999-01-21	48 Bailey Rd, Durham	F99-023002	Bullet lodged in house, determined to be 45 caliber ball.	1	
1997-03-02	22 Mauro Dr, Durham	F97-070862	3 bullets found, one lodged in house	3	
1996-12-29	256 Tri Mountain Rd, Durham	F97-070995	House struck by gunfire		
			Five additional complaints of projectile strikes from 1990-1997.	23	2

As is evident in the chart, the dispute between home-owners in the Town of the Durham and the owner of Blue Trail Range has been active for more than ten years. In September of 2009 the Town of Durham and Golden, Weise and Associates, LLC (GWA) entered into a contractual agreement to have GWA provide an analysis and provide a reasonable explanation as to the cause of the distress of these homeowners. The analysis described in the remainder of this document supports the following conclusion: It is very likely that prior to the range improvements made by the range owner under the guidance of Mr. Clark Vargas, PE; that the cause of distress to the Town of Durham Home-Owners was a combination of direct-fire and ricocheted projectiles originating at the Blue Trail Range and/or Blue Trail Range North. The improvements made seem to have reduced the volume of projectiles (based on a

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decrease in police reports) exceeding the Blue Trail Range boundaries; however, even if Mr. Vargas' statement is correct that direct-fire rounds are now adequately controlled, we do not feel that sufficient controls are in place to control those rounds that ricochet from various surfaces down-range. In the current configuration, the range has the potential to be a public health hazard. The residents of the Town of Durham near Tri Mountain Road have made it very clear that they feel no improvement is evident. We cannot substantiate or deny Mr. Vargas' findings until we are allowed access to the Blue Trail Range and Blue Trail Range North.

In addition to the Blue Trail Range, based on State Police Reports, the following ranges are, or have been, operational during the time the residents of Durham have voiced complaints:

The Wallingford Rod and Gun Club range was identified during investigations as a possible source for some of the projectile strikes. We evaluated their ranges in the same manner we evaluated the Blue Trail Range and determined that their main rifle range is sited in a position facing away from the Tri Mountain area. There is an additional range, reputed to belong to this organization, just north of the Blue Trail Range. This range was evaluated as well. The owners of Wallingford Rod and Gun have contacted the Town of Durham and deny that this range has anything to do with their operations. It has since been discovered that this range is located on property owned by the owner of the Blue Trail Range. For purposes of this technical evaluation we will refer to this range as "Blue Trail Range North".

The New Haven Raccoon Hunters Club was referenced as a potential source for projectile strikes; however, these strikes introduced an impact direction inconsistent with the majority of the complaints. According to the reports, modifications were made to the range and no additional complaints were attributed to this range.

The DiNatale residence was operating a home based range during the time some of the complaints were received; however, the direction of fire described in the State Police reports (North by Northwest) would not likely have been a source for projectiles. We have no survey information on this range; however it is evident that it may have created the potential for public health risk for those using the Blue Trail, Tri Mountain State Park and the George Washington Trail. We understand that this range is no longer in use.

The Miller residence, described as a "tree farm" was also listed as a home based range; however, we have no information on this range and find that it is highly unlikely that this range was responsible for projectiles traveling from West to East.

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Figure ES-2, Ranges Operational in the Area of Tri Mountain Road

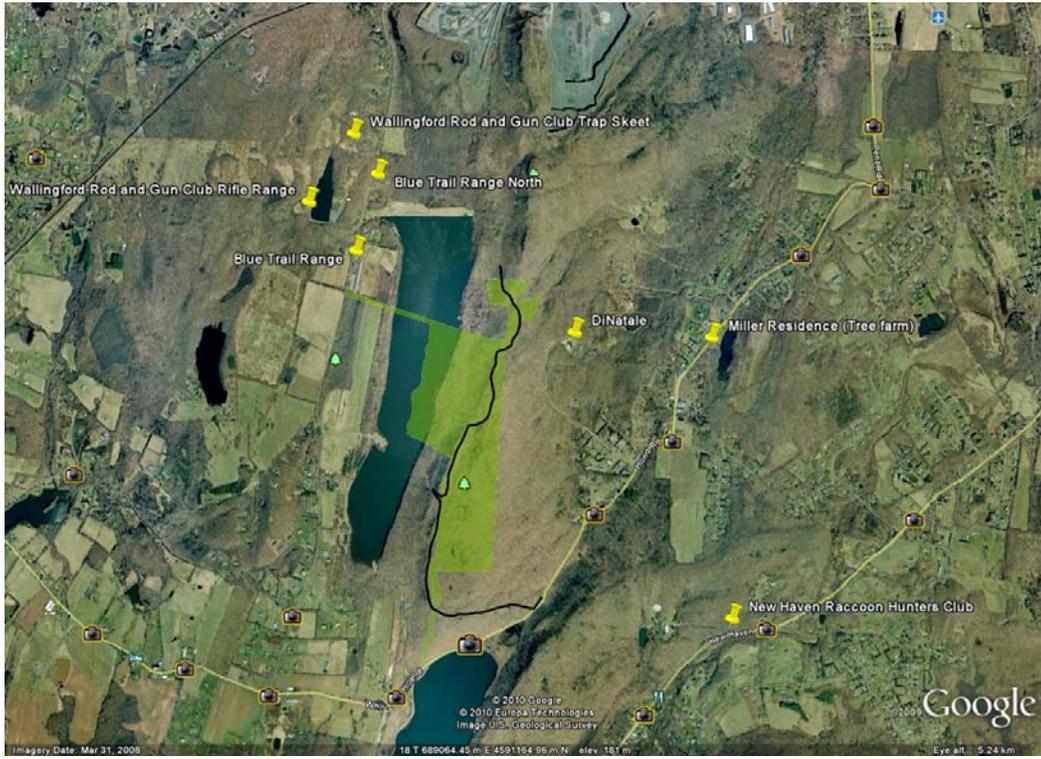
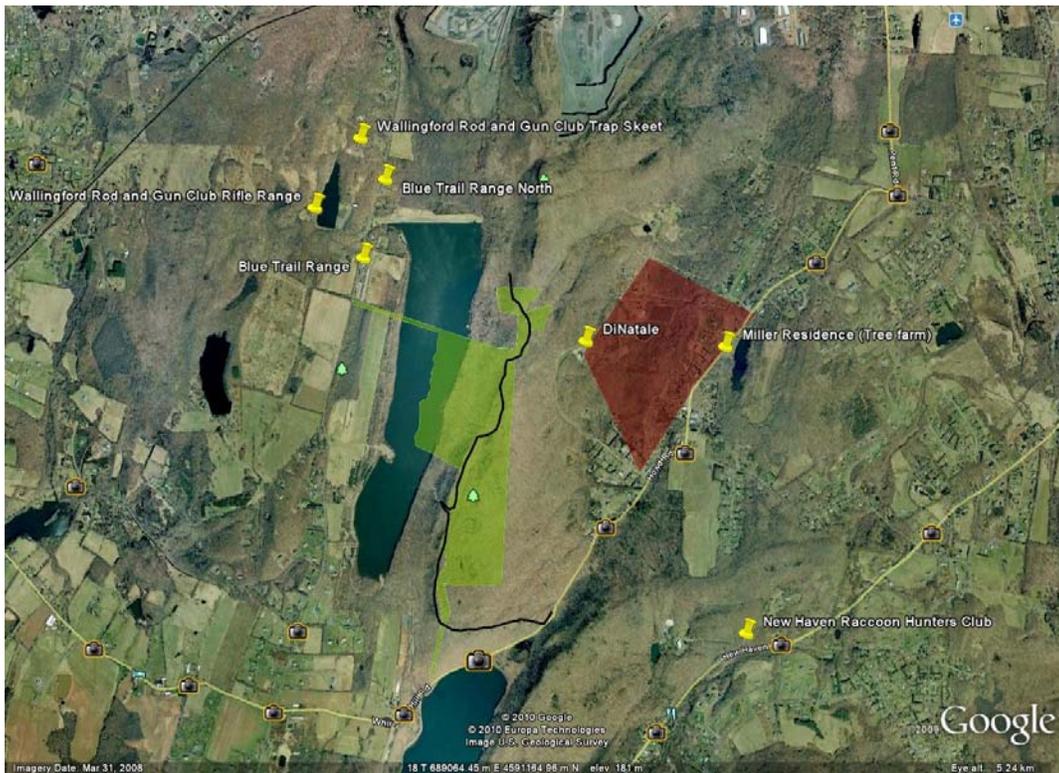


Figure ES-3, Bullet Strike Complaint Area



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Figure ES-4, Overview of the Potential Risk to Public Health Area - Uncontrolled

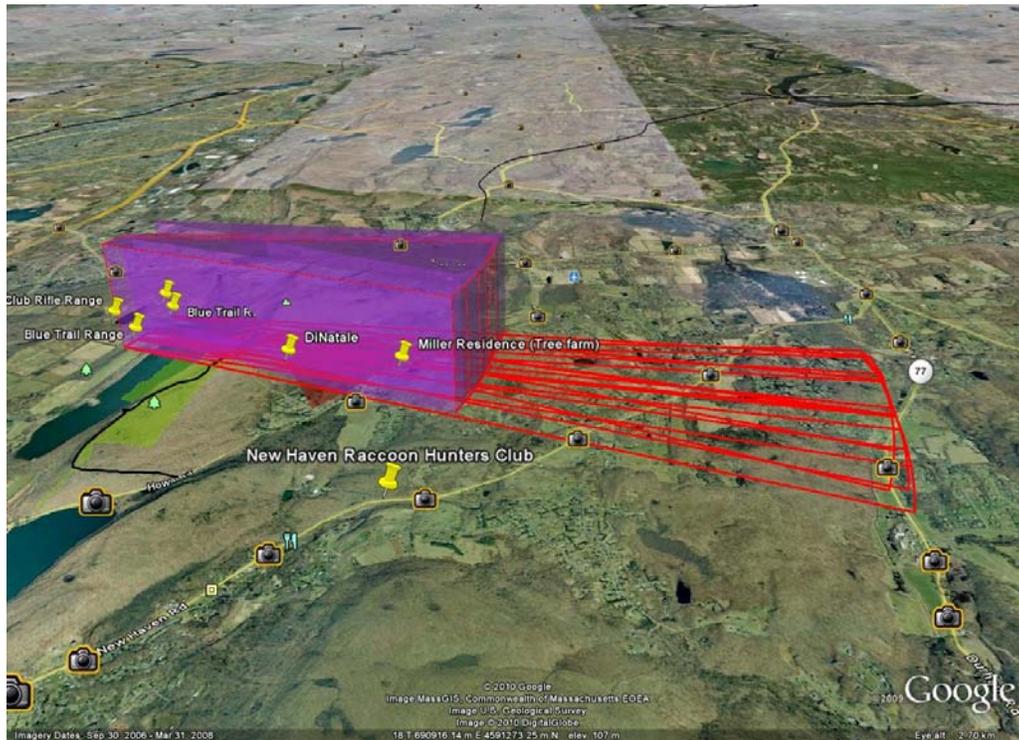
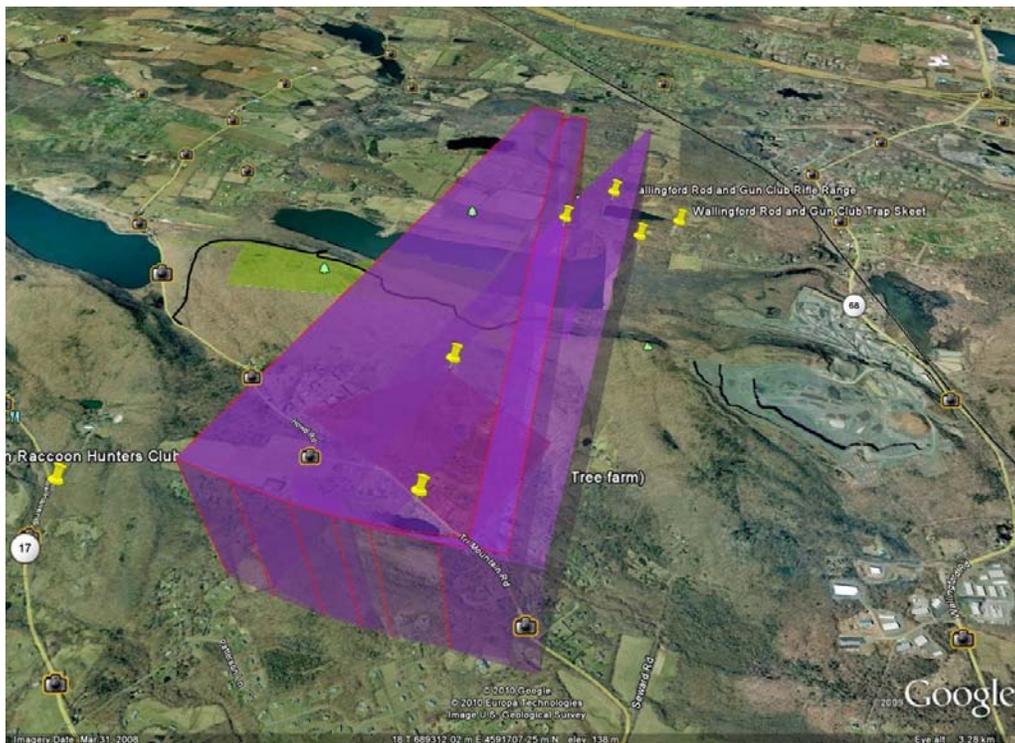


Figure ES-5, Overview of the Potential Risk to Public Health Area – Ricochet Only



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Technical Method of Evaluation

Background: In the spring of 2009 Mr. Charles Golden (CEO of Golden Weise and Associates, LLC) was approached by the Town of Durham with a request to evaluate complaints from the residents of Durham who are of the opinion that they are subject to undue endangerment based on projectile strikes to homes in the Tri Mountain Road area (as depicted in Figure ES-3) and substantiated by the subsequent State Police reports generated by resident complaints. In the fall of 2009 the Town of Durham placed Golden, Weise and Associates, LLC (GWA) on contract to review the evidence and conduct an evaluation of potential health risks to the residents of the area. In October 2009 the GWA staff traveled to the Town of Durham, met with the First Selectman, interviewed residents, conducted a terrain walk of the Tri Mountain State Park, and met with various public officials who were voicing the concerns of their constituents. We collected data from the Tax Assessor, received updated State Police investigation information and attended a meeting with representatives from the State Department of Environmental Protection and the Department of Natural Resources who are concerned with the use of the Tri Mountain State Park, the Blue Trail and George Washington Trail; that are all active public recreational areas where undue risks may also be present. We attempted to obtain admittance to the Blue Trail Range, currently in litigation for these problems; however, we were denied access. We were allowed to collect two range safety evaluations done for the Blue Trail Range by Mr. Clark Vargas of C. Vargas and Associates, LTD and the safety implementation policies and range design changes made in the summer of 2008 that were instituted as a result of his evaluations. There has been only one reported incidence of a confirmed projectile strike since these improvements were made; however, residents of the area still claim that they can hear projectiles striking branches in trees above their homes.

Evaluation Procedures: Evaluating civilian ranges for proper safety procedures is a tenuous task. There is little or no legislation in most areas of the United States for operating commercial ranges other than those designed to protect the employees of the complex. The National Rifle Association publishes The NRA Range Source Book which is an extremely valuable guide for the planning, design, operations and maintenance of shooting range facilities. After obtaining the most recent release of this reference, we determined that additional information was necessary to determine the probable causes of the reported incidents in the Tri Mountain area. As GWA primarily consults to the military on range safety issues, we determined that the use of Surface Danger Zones as described in Army Regulation 385-63 was needed to determine the correlation of incidents to the activities of ranges in the area. We further needed the guidance published in the Air Force Engineering Technical Letter (ETL 08-11) as it provides detailed guidance in the design of outdoor baffled ranges. The staff at GWA does not wish to enforce military construction standards on civilian range owners as these standards are cost-prohibitive to civilian range owners; however, in order to provide a reasonable explanation for the concerns of the citizens of the Town of Durham we determined that we needed more technical information than what was supplied by the NRA Source Book and it's guidance to range owners and operators.

Application of Surface Danger Zones: The definition of a Surface Danger Zone as provided in Army Regulation 385-63 is "The ground and airspace designated within the training complex (to include

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associated safety areas) for vertical and lateral containment of projectiles, fragments, debris, and components resulting from the firing, launching, or detonation of weapon systems to include ammunition, explosives, and demolition explosives.” Department of the Army Pamphlet 385-63 describes how these areas are calculated and drawn to determine the danger area produced by given ammunition type. For the purposes of this study common ammunition types were used to produce Surface Danger Zones. The chart below describes the ammunition types used and the ammunition types that were inferred as falling within the limits of the computed surface danger zones. There are many types of ammunition on the market and these may be fired from many different weapons. Both the ammunition and the weapons have distinct characteristics that determine what a projectile will do in flight if not impacted by an outside source. This list is designed to cover a broad range of possibilities.

Table TE-1, Pistol Ammunition Evaluation

Use P=Pistol, R=Rifle	Ammunition Caliber/Name	Calculated Maximum Range (meters - Military)	Calculated Maximum Range (meters - NRA Source Book)	Calculated Vertical Component (meters - earth/water impact)	Remarks
P	.32 Ball		1097		Contained in .45 ACP
P	.40 Magnum		1646		Contained in .45 ACP
P	.45 ACP	1690	1463	100	Evaluated
P	.22 Long Rifle	1400	1737		Evaluated - NRA Range Contained in 96 9MM Ball
P	9MM Ball	1800	1737		93 Evaluated
P	.38 Special Ball	1806	1737		Evaluated - NRA Range Contained in 89 9MM Ball

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Table TE-2, Rifle Ammunition Evaluation

Use P=Pistol, R=Rifle	Ammunition Caliber/Name	Calculated Maximum Range (meters - Military)	Calculated Maximum Range (meters - NRA Source Book)	Calculated Vertical Component (meters - earth/water impact)	Remarks
R	.22 Long Rifle (Hornet)	1400	1920	96	Evaluated
R	.222 Remington		2469		Included in 5.56 Ball
R	30-30 Winchester		2743		Included in 5.56 Ball
R	.22/250 Remington		2835		Included in 5.56 Ball
R	.220 Swift		2926		Included in 5.56 Ball
R	.257 Roberts		3018		Included in 5.56 Ball
R	.458 Winmag		3109		Included in 5.56 Ball
R	5.56 Ball	3100		325	Evaluated
R	.250 Savage		3200		Included in 7.62 Ball
R	.223 Remington		3475		Included in 7.62 Ball
R	.280 Remington		3840		Included in 7.62 Ball
R	.243 Winchester		4115		Included in 7.62 Ball
R	7.62 Ball	4100		706	Evaluated
R	8MM Mauser		4206		Included in 7.62 Special Ball
R	.375 H&H Magnum		4206		Included in 7.62 Special Ball
R	.270 Winchester		4298		Included in 7.62 Special Ball
R	300 H&H Magnum		4298		Included in 7.62 Special Ball
R	7mm Remington Magnum		4663		Included in 7.62 Special Ball
R	.300 Winmag		4755		Included in 7.62 Special Ball
R	30-06 Springfield		4937		Included in 7.62 Special Ball
R	.308 Winchester		5029		Included in 7.62 Special Ball
R	7.62 Special	5288		752	Evaluated
R	.338 Winmag		5486		Included in .50 Ball AP
R	.50 Cal Ball AP	6100		904	Evaluated

Application of Ricochet Probability from the Range: When designing ranges (military standard) the Blue Trail Range (Ranges One, Two and Three [Firing Positions 2-19]) as well as Blue Trail Range North would be considered “non-contained” ranges unless there is baffling in place that is not in the previous safety reports or evident in photographs or imagery. It is therefore probable that the unconstrained shooter could fire to the full extent of the Surface Danger Zone; the “unconstrained SDZ”. All ricochets from the target area could travel to approximately fifty-percent of the maximum range (as is directed on partially-contained ranges) according to the above referenced Air Force Technical Letter:

“7.1.1.3.2. All existing partially contained ranges that do not have the required SDZ must be programmed for upgrade or replacement to meet either full-distance; non-contained range criteria, fully contained range criteria, or the footprint of an existing deficient SDZ must be increased to meet the 50 percent SDZ requirement for a partially contained range. Existing partially contained ranges and other facilities designed in accordance with previously published criteria may continue to operate if range safety can be verified.”

Range Three (Firing Positions 20-120) and Range Four of the Blue Trail Range would qualify as partially-baffled ranges; although without having seen the baffling system we cannot attest to its effectiveness. There is baffling in place to preclude the exit of direct-fire rounds; however, there are no measures in place that prevent the exit of rounds that ricochet off of an object within the confines of the range. A fully-baffled range contains all rounds fired. The Connecticut Army National Guard is currently in the

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construction phase of a fully baffled range complex in East Haven and GWA has assisted in the design of this complex.

Figure TE-3 Example of a Fully-Baffled Range

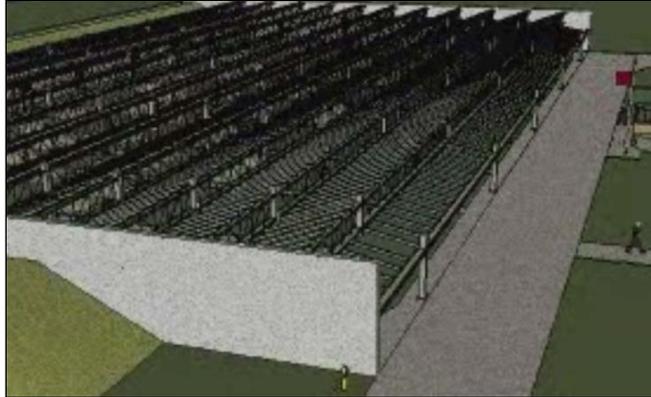


Figure 1 Firing Line View



Figure 2 - Behind Range View

The complex shown above is an approximately three million dollar project that accommodates pistols and rifles firing to a distance of twenty-five meters. These types of ranges are cost prohibitive for courses of fire requiring targets at 100 yards or more.

Ricochet Prediction and Control: Ricochets are difficult to predict or control and they are the primary cause of escapement on partially-baffled ranges. Unlike the Air Force, the Army does not allow the use of the fifty-percent Surface Danger Zone rule for partially-baffled ranges. The Army, at Picatinny Arsenal, uses software that was developed over a thirty year period to terrain mitigate Surface Danger Zones. The software models the terrain of the range as well as any manmade control devices (baffles) and through the software fires one-million rounds from each firing position to each associated target. This method produces the actual Surface Danger Zone for that range. To evaluate the ranges that may

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be causing the distress to the Town of Durham, the cost would be in excess of \$100,000. The drawings below show the Surface Danger Zone for a range in New York as well as the vertical dome produced by ricochets.

Figure TE-4, Range Ricochet analysis Using Government Owned Software



Vertical Hazard Zone: As depicted in Figure TE-4, ricochets have a vertical component and this vertical component, for the Army, is listed in Figures TE-1 and TE-2 and is derived from [DA Pamphlet 385-63](#). These calculations are used for determining the altitude over military ranges where airspace control measures must be initiated. These values are based on ricochets leaving the target area. In the drawings included with this analysis the vertical hazard area is drawn as a plane above ground level at the appropriate altitude, and is further depicted by drawing it out to fifty-percent of the maximum range.

Technical Evaluation Summary: Each of the ammunition types identified in Figures TE-1 and TE-2 have been evaluated according to the criteria described above and the following describes the steps and procedures used:

Step 1: Identify a firing box on each of the evaluated ranges that determines the area defined by the far left firing point and target point, and the far right firing point and target point.

Step 2: Apply the Surface Danger Zone for each of the ammunition types evaluated to determine the unconstrained hazard area. This is accomplished using ArcMap software and the Range Manager's Toolkit. The Range Manager's toolkit is Government-owned software used by all Army Range Managers.

Step 3: Apply the arc that will define the fifty-percent SDZ to the danger area computed in Step 2.

Step 4: Convert the final danger area into a format that will display in the public domain software "Google Earth" for the convenience of those who will be using this report and have no access to the ArcMap software.

Step 5: Apply the vertical component to the Surface Danger Zones in Google Earth.

Step 6: Evaluate the areas where there is a suspected issue with public safety hazards, and determine if there is a probability of a safety risk.

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Conclusions

Based on the information we have available, police reports and information generated from the previously discussed guidelines and standards the following conclusions are submitted. We will break these conclusions down into two sections. We will discuss the potential escapement possibilities prior to the range improvements made from the Vargas' recommendations.

Conclusions Based on Range Usage Prior to Safety Modifications.

1. Supervision of firing by all range users by certified range safety officers was not conducted at all times. This is a major safety violation on all civilian and military ranges.
2. The type of firing conducted by range users was not supervised at all times. This could include cross lane firing, firing in the air and firing at objects other than the prescribed targets.
3. The use of automatic weapons could have been conducted without direct supervision at all times. Automatic weapons, such as the Soviet and Chinese made AK -47 rifles have a tendency for the barrel to rise when fired in the fully automatic mode. Based on police reports, these weapons or ones similar to them were used on this range.
4. Access to the firing ranges was not controlled at all times.
5. Caliber and types of weapons used could not be verified by the range owners on a daily basis. These weapons and ammunition could include 50 caliber rifles and ammunition which can travel up to 6,500 meters or 4.03 miles unobstructed.
6. The 200 yard range has no backstop; therefore all ammunition fired was fired directly into or potentially over the downrange ridge line. The area commonly referred to in the police reports as "the bullet landing area" is actually known as an "impact area" in range terminology. This area is normally the area where rounds impact into the ground or ricochet in other directions, including vertically. Additionally, the 200 yard range could have supported firing by individuals in a prone position. Firing from the prone position at targets that are elevated would have raised the angle of fire from a flat trajectory. The upward angle would both increase the probability of firing over the ridge or creating ricochets that would have an increased probability of landing beyond the ridge.
7. The experience level and previous training of range users differed between expert users and novices. The resulting accuracy of fire and safety consciousness differs remarkably between the two groups. Novices are more likely to miss the target due to incorrect aiming points and more likely to fire over the target than experienced firers.
8. The original report provided by Mr. Vargas did not take into consideration the possibility of rounds ricocheting off of the ground or objects downrange and then striking the homes in the Tri Mountain Road area.

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9. These same conclusions can be used for all the Blue Trail Range since full time supervision of the ranges during all firing periods was not monitored or enforced.

10. It is our opinion that rounds fired from the 200 yard rifle range were the most likely cause of rounds striking the homes in the Tri-Mountain area. However, we also agree with the State Police that the only way to completely verify that Blue Trail Range or Blue Trail Range North were the source of the rounds is to match a weapon fired on the range with an associated projectile. Our opinion is based on the surface danger zones supplied in the Technical Evaluation, the potential for ricochets to occur from a range with no baffles or backstops, non-supervised firing, the use of automatic weapons and the direction of fire from the range to the residences impacted.

Conclusions Based on Range Usage after the Recommended Safety Modifications.

1. Supervision of all firers is now monitored and it is assumed that safety violations are corrected on the spot and violators are removed from the range.
2. Backstops have been raised and maintained based on Mr. Vargas' follow up visit on September 3, 2009 which should reduce the potential of direct fire projectiles escaping the range. We have not been allowed the opportunity to inspect this work.
3. Baffles have been added at the firing line which should reduce, but not totally eliminate, the chance for errant rounds to escape the range between the firing line and the back stops. There is still a potential for rounds to strike the range floor, target frames or backstop and ricochet over or off of the backstop and continue down range and/or other directions. The NRA defines a backstop as "A device constructed to stop or **redirect** bullets fired on a range. This is usually an earthen structure placed between 16 and 20 feet in vertical height, built in accordance with NRA recommended standards." As stated, backstops will not stop all bullets but may redirect some. The soil composition of the backstop (sand, rocks and gravel) and erosion are factors in the corresponding potential for escapement of projectiles. The baffles also do not extend overhead the length of the range from the firing line to the backstop as are required for "fully contained" compliance. Please refer to the definition of a Partially Contained Range in the Glossary. Also, see the [NRA Source Book](#) Diagram for an outdoor baffled rifle range. If the current baffling is insufficient, the danger area will extend to the full length of the Surface Danger Zone (unconstrained SDZ) for the ammunition fired.
4. The addition of security cameras should prove valuable in assisting in the enforcement of range safety regulations and determining if the range is accessed after normal operating hours if the cameras have the capability to view the entire range and are in use 24 hours per day. The cameras would also prove to be extremely valuable to the owners in the case of a range accident involving injury to a range user.
5. The use of automatic weapons is no longer allowed on the range.
6. The overall improvements to the range should reduce, but not totally eliminate the potential for escapement of projectiles from the range and should greatly enhance the safe operations of the range.

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7. Based on the definition of a Partially Contained Range and the Surface Danger Zone in Enclosure # 1 some areas of the Tri-Mountain State Park and Tri-Mountain Road will still be impacted by ricochets or unobstructed rounds leaving the ranges.

Additional information is included in each of the technical surveys of Blue Trail Ranges 1-4 and Blue Trail Range North in Enclosures 1-6.

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GLOSSARY OF TERMS

Backstop: A device constructed to stop or redirect bullets fired on a range. This is usually an earthen structure, placed between 16 and 20 feet in vertical height, built in accordance with NRA recommended standards.

Baffles: Barriers used to contain bullets and to reduce, re-direct or suppress sound waves and possible stray bullets. Baffles are placed either overhead, alongside or at ground level to restrict or interrupt errant or off target shots. A special baffle referred to as an eyebrow can be placed at the firing line to provide cover and minimize problems caused by double firing, or they can be placed atop backstops to ensure on-site containment of all fired rounds.

Berm: An embankment used between shooting ranges to divide them, or positioned to restrict bullets to a specific area. These are built to establish shooting lanes, and are usually 8 to 12 feet in vertical height.

Bullet trap: A device designed to trap or capture entire bullets or fragments versus redirecting the projectile into a water body, wetland or earthen backstop.

Distance X: The maximum distance a projectile will travel when fired or launched at a given quadrant elevation with a given charge or propulsion system.

Firing distance: The distance between the firing line and the target line.

Firing line: A line parallel to the targets, from behind which firearms are discharged.

Firing Range: (1) A facility designed for the purpose of providing a place on which to discharge firearms, shoot air guns and/or archery equipment; (2) May refer to several ranges constructed together, referred to as a complex or firing range complex.

Fully Contained Range: Range in which direct fire and ricochets are totally contained within the limits of the range. There is no SDZ requirement outside the limits of the containment.

Handgun: A term used to describe pistols, either auto-loading, single shot or cylinder types held in either one or two hands.

Impact Area: The area behind a target on a backstop or bullet trap where bullets are expected to impact. This term may also refer to an area down range at an outdoor range where bullets will impact if not captured by a backstop.

Line of site: An imaginary straight line from the eye through the sights of a firearm to the target.

Misfire: Failure of a bullet cartridge to discharge after the firearm's firing pin has struck the primer.

Non-contained Range (Impact): A non-contained range is an outdoor/open range. The firing line may be covered or uncovered. Direct-fire rounds and ricochets are unimpeded and may fall anywhere within the SDZ (safety fan). The non-contained range requires a safety fan (SDZ) equal to 100 percent of the

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maximum range of the most powerful round to be used on the range. This type of range requires the largest amount of real estate to satisfy the SDZ requirements.

Partially Contained Range: This range has a covered firing line, side containment, overhead baffles, and a bullet trap. Direct fire is totally contained by the firing line canopy, side containment; baffles and bullet trap (no blue sky observed from firing positions). Ricochets are not totally contained, but reduced by the baffles and side containment. A partially contained range requires a safety fan (SDZ) length equal to 50 percent of the maximum range of the most powerful round to be used on the range. A partially contained range will not permit lateral movement along the firing line or movement toward the target line unless the range has the additional baffles required to stop direct fire at the downrange firing lines.

Pistol: A firearm capable of being held, aimed and fired with one hand.

Range: The distance traveled by a projectile from a firearm to the final point of impact. Three terms apply to range: "point blank", "effective" and "maximum". For the purposes of shooting range design, point blank refers to distances of five yards or less, effective range means the greatest distance a projectile will travel with accuracy, maximum range means the maximum distance (Distance X) a projectile will travel.

Rifle: (1) A modern firearm designed to be fired from the shoulder, generally having a barrel more than 15 inches long. Its main characteristic is a rifled (knurled grooved) barrel that imparts a spin to a single projectile as it travels through the bore. (2) Some rifles designed for military or law enforcement use will have a pistol grip in lieu of a shoulder stock.

Safety rules and regulations: Standards used in the operation of a shooting range. Safety rules and regulations are set up to govern the method of range operation to include health and safety procedures that must be followed throughout the facility. Violation of range rules and regulations generally carries penalties such as suspension or banishment from a range for future use.

Safety baffles: Vertical or sloping barriers designed to prevent a projectile from traveling into an undesired area or direction. Most often used to prevent bullets from leaving the shooting range.

Shotgun: (1) A firearm designed to be fired from the shoulder with a smoothbore barrel that fires shot shells possessing a varying number of round pellets. (2) Some barrels are designed to be used with rifled slugs, most generally having smooth-bores, but in rare cases may be rifled. Law enforcement and military shotguns may have a pistol grip in lieu of a shoulder stock.

Shot shell: A shot shell is designed to be used in shotguns. It is composed of a hull or shell, a primer, powder, shot cup or wad and shot. Shells are normally composed of paper or plastic.

Small arms: Firearms that may be discharged by one person, versus artillery pieces. Small arms are not subject to precise definitions, but the term generally refers to rifles, pistols, shotguns, submachine guns and machine guns.

Small bore: An NRA-sanctioned shooting event using .22 rim fire rifles and bullets on bulls eye targets.

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Target line: A line parallel to the firing line along which targets are placed.

Trajectory: The path a projectile travels from the muzzle to the point of final impact.

Velocity: The speed at which a projectile travels (usually measured and reported in feet per second or meters per second).

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Golden, Weise, and Associates, LLC Information:

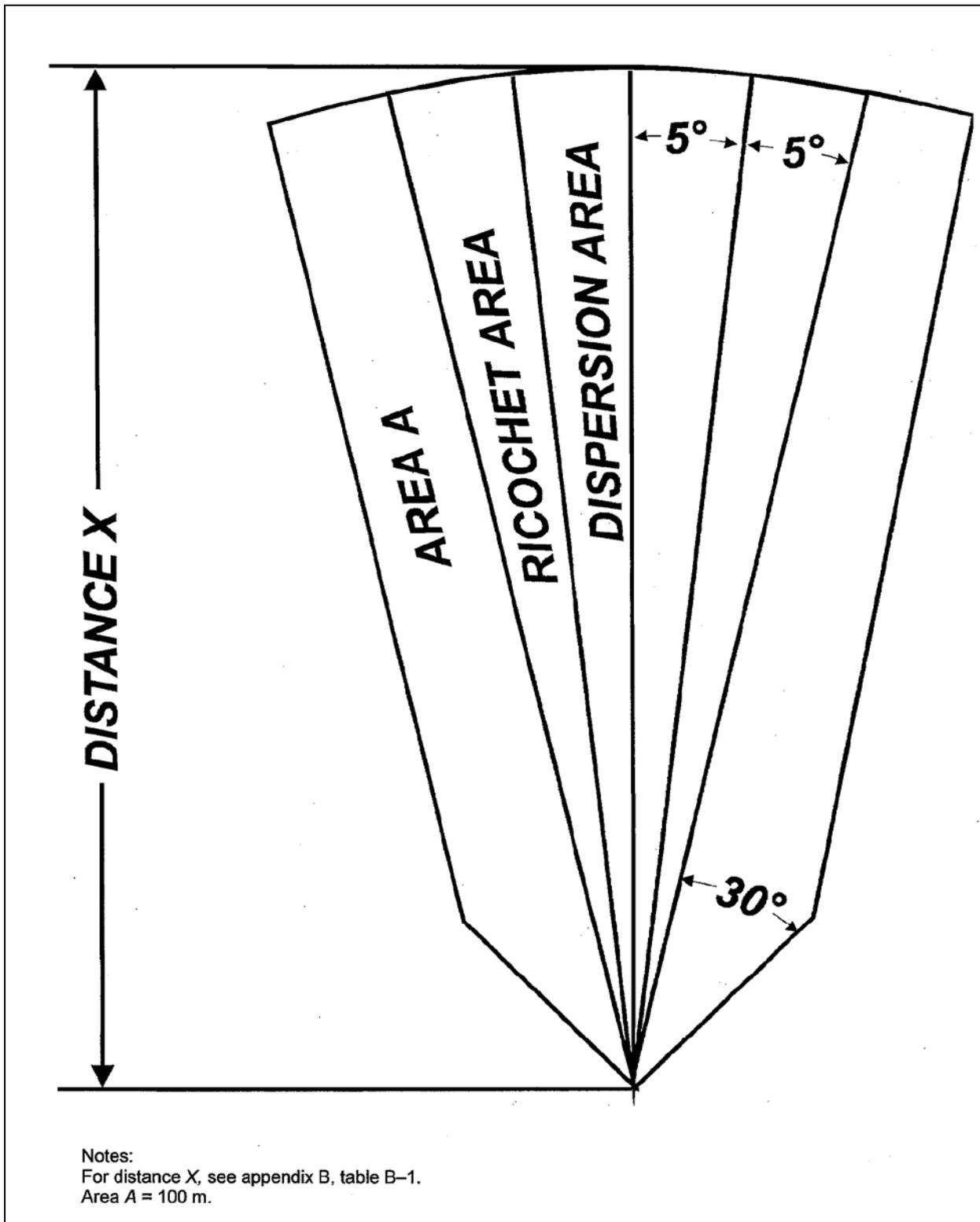
Golden, Weise, and Associates, LLC is a Veteran Owned, Small Business that specializes in range management and consulting services. GWA is currently under contract with the National Guard Bureau to support all National Guard Bureau range projects for approximately 60 National Guard installations. The managing partners have over 20 years of experience each in the operation, development, and management of US Army range complexes. GWA also is currently under contract with the National Guard Bureau to provide instructors and materials to teach the US Army, Training and Doctrine Command (TRADOC) approved Level II Range Safety Course. This course is the technical proficiency course that all US Army safety and range personnel attend for range safety certification. We have experience in providing range consulting services in the United States, Puerto Rico, Guam and Afghanistan. All members of our safety team are graduates of the US Army Level II Range Safety Course and sometimes serve as instructors on an as required basis.

We are the principle manager for the Army National Guard's live fire ranges for all fifty states and four territories. We assist in managing and supporting over 50 National Guard installations with their ranges and range related issues. We have managed one of the largest National Guard complexes in the country that had over sixty live fire ranges. We have provided safety inspections and investigations for all types of ranges ranging from small arms to tank and aviation gunnery ranges. We have assisted in the design and construction of ranges for law enforcement including the Florida Department of Law Enforcement. GWA is also a member of the NRA Business Alliance. We are currently assisting the Connecticut Army National Guard with the design and development of a baffled range complex at East Haven, Connecticut. It should be noted here that the range in East Haven had escapement issues over a ridge line and into a reservoir and was subsequently evaluated and designed to contain ALL ammunition fired on the range. This not only mitigated the escapement problem but entirely eliminated it.

Enclosures:

1. SDZ for firing small arms, machineguns, and shotguns firing at a fixed ground target from DA Pamphlet 385-63, Range Safety.
2. SDZ for BTR Range 1 (Dinan pistol Range) and range safety discussion with recommendations.
3. SDZ for Range 2 (200 yard range) and range safety discussion with recommendations.
4. SDZ for Range 3 (pistol only) and range safety discussion with recommendations.
5. SDZ for Range 3 and 4 and range safety discussion with recommendations.
6. SDZ for Blue Trail Range North and range safety discussion with recommendations.

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Enclosure #1 – Surface Danger Zone for Firing Small Arms, machineguns and shotguns at fixed ground target.