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Attention: Mr S. Teo

**500 METRE RANGE AND 50 METRE RANGE TESTING - COMPLIANCE TEST**  
**SOUTHERN HIGHLANDS REGIONAL SHOOTING CENTRE**  
**WATTLE RIDGE ROAD, HILL TOP**

The purpose of this report is to present the results of acoustic testing carried out on Friday 15 February 2019 in relation to shooting on the 500 metre range and 50 metre range at the Southern Highlands Regional Shooting Centre.

A previous test was conducted in September 2018 as part of the compliance process during the construction of the two shooting ranges. At that point in time, the 50 metre range had the walls separating the individual ranges installed, but the roof structure above the firing positions on the 500 metre range and 50 metre range had not been constructed.

The February 2019 testing relates to the completed construction of the 500 metre and 50 metre shooting ranges.

Testing of the two shooting ranges was undertaken during the late morning between approximately 10:30 am and 1:00 pm. The testing occurred at residential reference locations A1 and A4A, which have been nominated by the EPA on previous testing programs (see Appendix A). Location A1 is in the cul-de-sac at the end of Rocky Waterholes Road, whilst Location A4A is in the public carpark adjacent to the residential boundary to the north-east of the shooting ranges.

No resident observers were present during the monitoring. However, there were intermittent interference to the measurement results from wind gusts, vehicles and aircraft in proximity to the monitoring locations.



Consistent with previous testing, the Peak Hold measurement results are presented as arithmetic levels and as an absolute level for the monitoring locations.

Due to the characteristics of a pressure wave from an explosion, noise measurements of shooting ranges use the “Linear Peak Hold” or the Z-weighted Peak Hold measurement. This descriptor indicates the absolute maximum level measured for each shot using a Linear (no weighting) frequency response. Originally for shooting assessments, the State Pollution Control Commission (the “**SPCC**”) used the logarithmic average of the shots for the determination of compliance with criteria – being based on the procedure used by the National Acoustics Laboratories for their investigation of the Hornsby Rifle Range and the Holsworthy Military Range.

Issues as to the methodology of determining the measured level for compliance purposes of the subject range (absolute level, logarithmic average or arithmetic average) and separation of wind have been raised leading to the EPA issuing the document *Target Shooting Ranges: Application Note for Assessing Noise Compliance* which identifies the use of arithmetic average.

The presence of calm wind conditions for a majority of the time during the monitoring permitted observation of the influence of occasional wind gusts and other extraneous noises on the measurement results.

## Measurement Instrumentation

For the purpose of compliance testing, attended measurements were conducted at reference locations A1 and A4A.

Attended sound level measurements at the residential reference location identified in Appendix A as Location A1 were carried out using a Bruel & Kjaer Sound Level Meter Type 2250 (serial no. 3009280), with a SVAN 979 Sound Level Meter (serial no. 35808) for backup.

The attended measurements at Location A4A were carried out using a Bruel & Kjaer Sound Level Meter Type 2270 (serial no. 3009636) with a SVAN 979 Sound Level Meter (serial no. 27164) for backup.



Unattended measurements to the rear of the firing positions on the 500 metre range were conducted using a SVAN 957 Sound Level Meter (serial no. 23806), whilst the unattended measurements at the rear of the firing positions on the 50 m range were conducted using a Bruel & Kjaer Sound Level Meter Type 2250 (serial no. 3004338)

All sound level meters are classified as Class 1 meters, incorporate Z-weighting filters and set to record/display the peak hold level. All sound level meters are calibrated to manufacturer's or NATA standards traceable to the National Measurement Institute (NATA Registered Laboratory No. 1).

The reference calibration level of each meter was checked prior to and after measurements with a Bruel & Kjaer Sound Level Calibrator Type 4231 or Type 4230 and exhibited no system drift.

## Measurement Procedures

Previous measurements related to the subject shooting range have involved different locations for assessing the noise. The updated conditions of consent required noise testing at the two locations nominated by the EPA.

The February 2019 testing was undertaken with monitoring at Locations A1 and A4A (same monitoring locations as the September 2019 testing), which are adjacent to the boundary of residential properties to the south-east and north-west of the shooting centre respectively.

Appendix A identifies the residential measurement location used for this compliance test as well as measurement locations in residential areas used in previous tests.

Similarly to the September 2019 testing, the compliance testing of the 500 metre range utilised a 308 rifle at 6 different shooting positions and 10 shots per shooting position. Table 1 below sets out the program of the testing that was carried out for the 500 metre range.



**TABLE 1: Testing Program 500 Metre Range**

Firing Position	Firearm
Left Lane – Prone	308 Rifle
Left Lane – Standing	308 Rifle
Centre Lane – Prone	308 Rifle
Centre Lane – Standing	308 Rifle
Right Lane – Prone	308 Rifle
Right Lane – Standing	308 Rifle

We are advised that the testing of the 500 metre range utilised factory ammunition for the 308 rifle being Federal 150 grain soft point ammunition.

The 50 metre range has five individual ranges (Ranges 1 – 5 with Range 1 being an open range) which are separated by barriers between the ranges and each range having a number of lanes. We are advised that Range 5 is the furthest range to the right on the north-western side of the 50 m range (closest to Wattle Ridge Farm/Location A4A), whilst the Range 1 is furthest range to the left on the south-eastern side of the 50 m range.

We are advised that the program for the compliance test of the 50 metre range nominated 10 shots in the **centre lane** of each individual range. Table 2 below sets out the program of the testing that was carried out for the 50 metre range (centre lane).

**TABLE 2: Testing Program 50 Metre Range**

Firing Position	Firearm
Range 5 – Standing	9 mm Pistol
Range 4 – Standing	9 mm Pistol
Range 3 – Standing	9 mm Pistol
Range 2 – Standing	9 mm Pistol
Range 1 (open range) – Standing	9 mm Pistol

We are advised that factory ammunition was used in the pistol for the testing of the 50 m range, being 9 mm Geco 115 grain Jacketed Hollow Point projectiles.

For all of the shots, noise levels were monitored at a position to the rear and side of the firing positions at the 500 metre and 50 metre ranges so as to identify the occurrence of shots.



In general environmental acoustics, the dB(A) value is the normal acoustic parameter. dB(A) is the decibel value using the A-weighted filter curve, which approximates the response of the human ear to level around 40 dB(A).

The A-weighting filter (being an electronic RC equivalent circuit) has a response curve that is too low for short duration peak pulses such as for shooting. As the use of dB(A) underestimates the total energy generated by shooting, the use of Linear Peak Hold measurements address the problem with dB(A) FAST Response measurements.

Whereas Peak Hold measurements were originally defined as a Linear Peak Hold, instrumentation today refers to the Z-weighted levels that may approximate the Linear Peak Hold result for frequencies above 10 Hz. The EPA's Application Note (*Target Shooting Ranges: Application Note for Assessing Noise Compliance*) refers to the level to be recorded as the Z-weighted Peak Hold level ("LZpeak").

In view of the need to obtain Peak Hold measurements each sound level meter was set to measure and display the Z-weighted Peak Hold value with the TAG monitoring personnel at Locations A1 and A4A manually writing down the results (including any extraneous noise or wind) when a shot was audible. The instrumentation used for measurement has a designated time delay for showing the peak level that generally would include the peak pressure level from the shot as well as the peak pressure level from wind if present at the same time of the shot or shortly thereafter.

In the case of impulsive noise from rifle shots the maximum overpressure of the sound wave (the linear or Z-weighted peak hold pressure level) is commonly used to measure the absolute pressure.

Because the peak pressure hold level is a measurement parameter that has no frequency weighting and has no relationship to the A-weighted RMS level used for environmental assessments, there is an entirely different relationship between measured levels and audibility.

For A-weighted levels one can hear a noise at levels 10 dB or more below the background level. For measurements when a noise is 10 dB below the background there will be no measurable increase above the background level (for either a linear level or an A-weighted level).



In using the peak hold level, a shot may be audible but show no measurable increase above the ambient background level on the meter, due to the relationship of the actual level versus the ambient/background level. At other times a shot may be audible and give rise to a measurable increase above the ambient background level, but the measured level may be the result of the shot, or wind, or extraneous noise.

In view of the variability in measured noise levels both during shooting and without shooting occurring, it is necessary to undertake attended measurements to identify the occurrence of distinct shots (identified by the EPA as the “manual method”).

In the first instance an evaluation is able to be undertaken using the observed measured levels to indicate the range of levels occurring during the testing.

One then utilises the EPA “post-processing analysis”, to verify the observed/measured shots in the environment in which they occur.

The post-processing analysis can provide the ability to correlate the residential receiver measurement results with the log of shots fired on each range, primarily to address when shots are inaudible.

As experienced in previous testing at Hill Top it was found at the residential receivers, that apart from shots that are inaudible or not measurable in the ambient noise, the presence of a variable wind may provide limitations in obtaining valid measurements.

## **Measurement Results – Manual Method**

The measurement results for the compliance testing of the 500 metre range are provided in Appendix B for Locations A1 and A4A, whilst the measurements results for the compliance testing of the 50 m range are provided in Appendix C for Locations A1 and A4A.

The results include observations noted by the TAG monitoring personnel during the compliance tests which include a coding that identifies the presence of wind (“XW”) and extraneous noise (“XR”) that impacted upon the individual shot or inability to record a measurable increase (“X”).



During the monitoring the wind conditions at Location A1 were generally calm, but at times the occurrence of wind gusts would give rise to elevated peak levels that affected the monitoring results.

At Location A1, the measurements were occasionally affected by aircraft flying in proximity to the monitoring location and two vehicles were observed on Rocky Waterholes Road during the monitoring. One of the vehicles left the premises at the end of Rocky Waterholes Road, whilst the other vehicle was an Australian Post motorcycle that entered the cul-de-sac to deliver post and then left shortly afterwards.

Location A4A had light north-easterly winds during the monitoring which gave rise to elevated ambient peak levels as a result of the rustling of leaves in proximity to the monitoring location.

At Location A4A, domestic commercial aircraft flying in proximity to the monitoring location and three vehicles were observed during the monitoring. One of the vehicles conducted a U-turn at the end of the road and left shortly thereafter. The other two vehicles entered and parked at the carpark, with the occupants of those vehicles leaving the carpark on foot (presumably to go hiking).

It is noted that at Location A4A, a majority of the rifle shots on the 500 metre range were inaudible. In terms of the pistol shots on the 50 m range, a majority of the shots could not be detected at both residential monitoring locations. In view of the majority of the shots being inaudible/barely audible, for the purpose of providing meaningful results under the EPA's document it is necessary to also refer to the on-site measurements conducted on the 500 metre and 50 metre ranges.

Appendices D1 and E1 present tables of the measurement results recorded towards the rear of the firing position on the 500 metre and 50 metre ranges. The tables are followed by graphical presentations showing the levels recorded over time. As expected, the on-site measurement results reveal consistent high peak levels in proximity to the firing positions.

The graph of the on-site measurement results show that there was generally a 60 second interval between the shots so as to assist in the identification of the shots at the residential assessment locations (Locations A1 and A4A). In order to undertake the analysis of the peak pressure levels obtained at the residential locations, all of the individual shots were correlated with respect to the time of the shot occurring on the range.



## Post-Processing – EPA Method

Appendices B and C provide tables of the measurement results (at Locations A1 and A4A) for the compliance test of the 500 metre and 50 metre ranges respectively.

From observations of the sound level meter during testing, it has been found that the noise level of the shots is generally at or below the ambient peak levels at the residential reference locations and the occurrence of wind or extraneous noises (such as birds and planes) can generate levels significantly greater than that of the shots. Therefore, the procedure of using the on-site material is required to be undertaken as the shots can be audible but cause no measurable increase above the ambient level at the residential locations.

Due to the distance between the shooting ranges and the receiver locations and that sound travels approximately 320 metres per second, one can expect the shot to be detected at Location A1 and A4A after the time of the shot is recorded at the on-site measurement location. From comparisons between the timing of the shots detected by the TAB monitoring personnel at the residential receiver locations and the on-site measurement results, adjustments for the difference between the on-site shot time and the recorded time at the residential receiver can be determined.

Appendices D2 and D3 present the recorded measurements at Locations A1 and A4A respectively which have been superimposed onto the graphical results from the recorded measurements at the 500 metre range with the appropriate timing correction to permit synchronisation of the actual shot and identification of extraneous noise that is not associated with the shot.

A similar exercise is presented in Appendix E of the superimposing the recorded measurements at the residential locations onto the graphical results from the recorded measurements at the 50 metre range.

Comparisons between the field observations and the post-processed results reveal general agreement.

The occurrence of a shot can easily be identified in the time space graph of the on-site measurements due to the peak level (LZpeak) of the shot being over 100 dB and much greater than the ambient level.





The red graphs in Appendices D2 and D3 are the Z-weighted peak hold level recorded at Locations A1 and A4A respectively. As a result of distance attenuation to the residential receiver, the noise level of the shots do not give rise to distinct peaks because they are generally in the same order of magnitude or lower than the ambient Z-weighted peak hold level. The fluctuations in the average minimum level in the red graphs identify the presence of extraneous noise.

The green graphs in Appendices D2 and D3 are the A-weighted Sound Exposure Level (“SEL”) at 1 second increments at Locations A1 and A4A respectively. The green graphs are able to show audible noise events associated with extraneous noise sources such as planes. The A-weighted SEL is a 1 second energy average of the A-weighted level and identifies a noise over a longer period than just a shot that as such displays the general trend in the ambient (or extraneous) noise.

As the influence of ambient/extraneous noise can greatly affect the peak level (LZpeak) so as to be greater than the noise level of gunshots at times, it becomes a difficult (and time consuming) exercise in differentiating peaks in the time splice graph relating to gunshots and peaks from extraneous/ambient noise.

The LZpeak levels of gunshots at the residential monitoring locations were determined with assistance from the attended measurement notes as well as the accurate timing of shots from the on-site measurement results.

Utilising a post-processing method to determine the noise level of shots, there is difficulty in identifying shots from observation of the LZpeak time splice as the shots are around the same level to that of the ambient background noise. We have used the results from a sound level meter located on the shooting range to identify the occurrence of shots for comparison with the residential results, which is a method approved by the EPA. This method involves time synchronising the measurement results at the residential locations to the results from the shooting range to account for the sound delay due to the speed of sound and the distance between the shooting range and the residential locations.

With respect to the post-processing undertaken for Location A1, NSW EPA document *Target Shooting Ranges: Application Note for assessing Noise Compliance* (“Application Note”) provides guidance on compliance assessment of shooting noise at shooting ranges. The preparation of the Application Note had the benefit of testing undertaken by the EPA in 2014 at Hill Top.



The methodology provided by the document seeks to characterise audible shots as “Category A” or “Category B”.

A “Category A” shot represents an accurate measurement of the noise contribution from the shot and is categorised as having a distinct peak level noticeably higher than the peak level immediately before the shot which is not attributed to wind gusts or other extraneous noise.

A “Category B” shot represents an upper estimate of the contribution from the shot and is defined as a shot which has a peak level that may have been elevated by wind gusts or other extraneous noise.

Section 4.3 of the Application Note requires the post-processing method of measuring shot noise of an operational range to categorise shots into “Category A” and “Category B” by comparison of the shot peak level to the peak level immediately prior to the shot. Shots 5 dB greater than the immediately preceding level are categorised as “Category A” whilst shots less than 5 dB above the preceding level are categorised as “Category B”. An identified shot having a peak noise level that is less than the peak level immediately prior to the shot is considered invalid and discarded from the analysis.

Under the Application Note, calculation of the final noise level is determined by whether the number of “Category A” shots measured is less than or greater than 50. For the scenario of greater than 50 “Category A” shots measured, then the final noise level will be the arithmetic average of all “Category A” shots within one hour of commencing measurement. If the number of “Category A” shots is less than 50, then the final noise level will be the arithmetic average of all shots (“Category A” and “Category B”).

Appendix F presents the application of the EPA post-processing method.

The time splice graphs in Appendix F are set out in the same format as the example in the EPA’s Application Note and provides the results obtained at Locations A1 and A4A for a 5 minutes sample of the 500 metre range test. An expanded view of the measurement results is required so as to clearly show the timing of the shots and the relevant peak levels that cannot be derived from the graphs in Appendix D and E that cover the entire period.



The blue line of the time splice graph in Appendix F represents the LZpeak levels recorded at Locations A1 and A4A respectively with green markers superimposed onto the graph to identify the occurrence of a shot. The EPA procedure requires that where a marker immediately precedes/succeeds a peak in the time splice graph, then the marker is re-assigned to align with the peak (illustrated by a red marker). This is because the clock time displayed on the meter is running in seconds (and used manual notations) and therefore not as precise as the time splice output.

Appendices F2 – F5 provide tables of the measurement results for Location A1 in the format presented in the EPA's Application Note, whilst Appendices F7 – F10 provide a table of measurement results for Location A4A.

## **Analysis**

At the residential reference locations, there were a few occasions during the course of the monitoring where wind gusts were present and influenced the measurement results.

In accordance with the EPA procedure, measurement results that were affected by wind or extraneous noise (such as planes, dogs, vehicles, etc.) have been excluded from the analysis.

From the measurement results in Appendix B, the arithmetic average and the absolute peak of the unaffected individual peak hold results for the testing of the 500 metre range have been provided in Table 3.



**TABLE 3: 500 m Summary of Manual Results**

Test	Measured Shooting Levels (Peak Hold dB)			
	Min	Max	Arithmetic Average	No of Shots Measured
<b>Location A1 (308 Rifle)</b>				
Left Lane Prone	58	65	62	6
Left Lane Standing	57	62	60	6
Centre Lane Prone	58	68	64	10
Centre Lane Standing	59	69	65	8
Right Lane Prone	59	66	63	7
Right Lane Standing	60	67	63	9
Total of all rifle shots	57	69	63	46
<b>Location A4A (308 Rifle)</b>				
Left Lane Prone	63	67	65	5
Left Lane Standing	64	66	65	2
Centre Lane Prone	54	54	54	1
Centre Lane Standing	64	64	64	1
Right Lane Prone	62	62	62	2
Right Lane Standing	64	71	68	5
Total of all rifle shots	54	71	65	16

Table 4 below presents the arithmetic and absolute peak of the unaffected individual peak hold results for the testing of the 50 metre range (from the manual results in Appendix C). For both residential monitoring locations, a significant number of shots at the 50 m range could not be detected/measured.



**TABLE 4: 50 m Summary of Manual Results**

Test	Measured Shooting Levels (Peak Hold dB)			
	Min	Max	Arithmetic Average	No of Shots Measured
<b>Location A1 (9 mm Pistol)</b>				
Centre of Range 5	-	-	-	0
Centre of Range 4	59	61	60	3
Centre of Range 3	58	60	59	3
Centre of Range 2	55	61	57	3
Centre of Range 1	54	62	57	4
Total of all recorded shots	54	62	58	13
<b>Location A4A (9 mm Pistol)</b>				
Centre of Range 5	61	65	64	4
Centre of Range 4	61	61	61	2
Centre of Range 3	59	61	60	3
Centre of Range 2	-	-	-	0
Centre of Range 1	58	58	58	1
Total of all recorded shots	58	65	61	10

From the results in Appendix F obtained using the EPA's post-processing method, the arithmetic average and the absolute peak of the unaffected individual peak hold results for the testing of the 500 metre range and 50 metre range have been provided in Table 5 and Table 6 respectively.

It is noted that the EPA post processing results can provide both higher and lower number of "measurable" shots when compared to the manual method.



**TABLE 5: 500 m Summary of Results (post-processing method)**

Test	Measured Shooting Levels (Peak Hold dB)			
	Min	Max	Arithmetic Average	No of Shots Measured
<b>Location A1 (308 Rifle)</b>				
Left Lane Prone	58	65	62	Category A: 3 Category B: 2
Left Lane Standing	59	65	61	Category A: 0 Category B: 6
Centre Lane Prone	58	69	65	Category A: 2 Category B: 6
Centre Lane Standing	59	68	64	Category A: 5 Category B: 3
Right Lane Prone	59	67	64	Category A: 2 Category B: 6
Right Lane Standing	60	67	63	Category A: 2 Category B: 6
Total of all rifle shots	58	69	63	Category A: 15 Category B: 28
<b>Location A4A (308 Rifle)</b>				
Left Lane Prone	63	69	66	Category A: 0 Category B: 3
Left Lane Standing	68	69	69	Category A: 0 Category B: 2
Centre Lane Prone	-	-	-	Category A: 0 Category B: 0
Centre Lane Standing	62	62	62	Category A: 0 Category B: 1
Right Lane Prone	65	66	65	Category A: 0 Category B: 2
Right Lane Standing	64	71	69	Category A: 0 Category B: 4
Total of all rifle shots	63	71	67	Category A: 0 Category B: 12



**TABLE 6: 50 m Summary of Results (post-processing method)**

Test	Measured Shooting Levels (Peak Hold dB)			
	Min	Max	Arithmetic Average	No of Shots Measured
<b>Location A1 (9 mm Pistol)</b>				
Centre of Range 5	-	-	-	Category A: 0 Category B: 0
Centre of Range 4	58	61	59	Category A: 0 Category B: 3
Centre of Range 3	58	64	60	Category A: 0 Category B: 3
Centre of Range 2	55	61	57	Category A: 0 Category B: 3
Centre of Range 1	55	62	59	Category A: 1 Category B: 2
Total of all measurable shots	55	64	59	Category A: 1 Category B: 11
<b>Location A4A (9 mm Pistol)</b>				
Centre of Range 5	64	68	65	Category A: 1 Category B: 3
Centre of Range 4	61	67	64	Category A: 0 Category B: 2
Centre of Range 3	59	67	63	Category A: 0 Category B: 3
Centre of Range 2	-	-	-	Category A: 0 Category B: 0
Centre of Range 1	58	58	58	Category A: 0 Category B: 1
Total of all measurable shots	58	68	64	Category A: 1 Category B: 9

The current results agree with previous testing that when the majority of the shots are audible, the manual and EPA analysis methodology give similar results (i.e. in this case for Location A1 for both ranges). Where the locations experience inaudibility for the majority of the shots, the EPA methodology will result in higher levels (i.e. in this case for Location A4A the EPA method gives a 2 – 3 dB higher average level than the manual method).



In terms of the measurement results (both manual method and the EPA method) as an absolute maximum peak hold level, the operation of firing from the at the 500 m range did not exceed 69 dB at Location A1 and 71 dB at Location A4A. For the testing of the 50 m range, the absolute maximum peak hold level of the shots did not exceed 64 dB at Location A1 and 68 dB at Location A4A.

In comparison to the September 2018 testing results (which did not have a roof structure over the firing positions), a significant number of shots on the 500 metre range and 50 metre range were inaudible Location A4A during the February 2019 testing. At the two residential monitoring locations (Locations A1 and A4A), there is a general reduction of the peak hold levels for the operation of the 50 metre range. For the operation of the 500 metre range, the February 2019 testing revealed similar peak hold levels to the September 2018 testing.

Compliance testing of the Southern Highlands Regional Shooting Centre was carried out on Friday 15 February 2019, after completion of the constructions of the 500 metre and 50 metre shooting ranges. The testing when analysed by the manual method and the EPA method found the noise levels of the shots at the 500 metre and 50 metre ranges to be significantly below the noise target of 75 dB as an arithmetic level at residential receivers.

Yours faithfully,

**THE ACOUSTIC GROUP PTY LTD**



**CHRISTOPHER Y. H. CHAN**

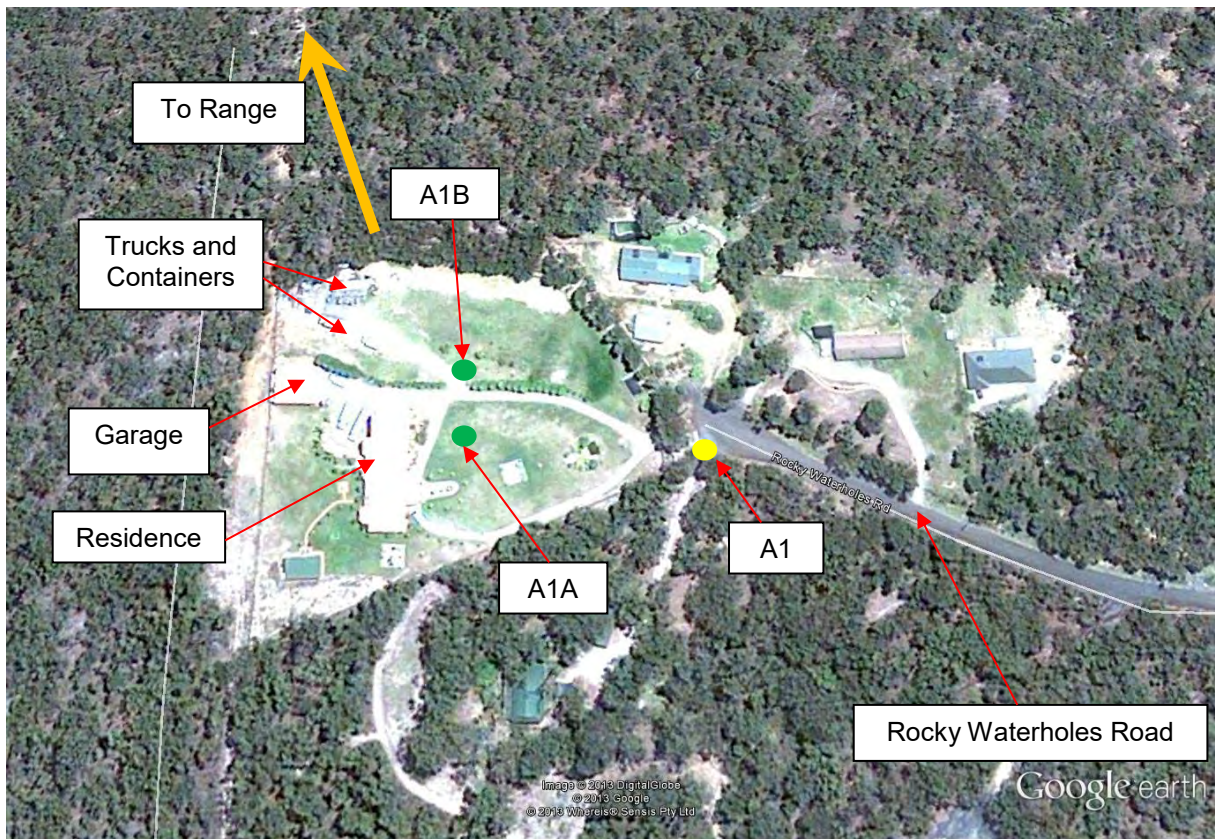
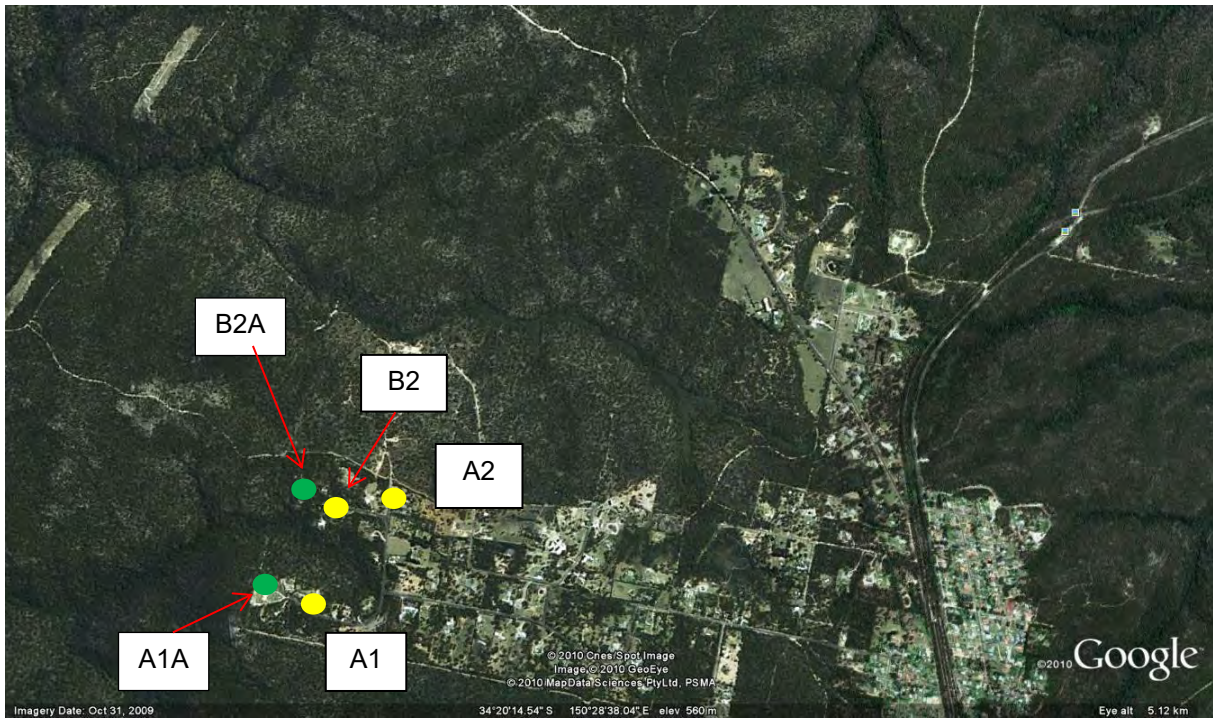




**APPENDIX A:**      **Measurement Locations**







## **APPENDIX B: Measurement Results (500 metre range test)**

### **Measurement Location A1 – Rocky Waterholes Road**

Prone Left Lane (308 Rifle)									
62	61	XW	65	65	X	58	59	XW (76)	XW (69)
Standing Left Lane (308 Rifle)									
XW (74)	XW (65)	XW (71)	62	57	59	60	59	60	XR (71)
Prone Centre Lane (308 Rifle)									
68	66	65	68	61	64	63	58	65	65
Standing Centre Lane (308 Rifle)									
65	67	68	66	63	59	69	64	XW (74)	XW
Prone Right Lane (308 Rifle)									
65	66	65	59	60	NA	66	61	XW (71)	XW
Standing Right Lane (308 Rifle)									
60	61	66	63	XW (75)	63	66	67	60	60

### **Measurement Location A4A**

Prone Left Lane (308 Rifle)									
NA	NA	NA	63	66	65	NA	67	NA	66
Standing Left Lane (308 Rifle)									
NA	64	NA	NA	66	NA	NA	NA	NA	NA
Prone Centre Lane (308 Rifle)									
NA	NA	NA	NA	NA	NA	54	NA	NA	NA
Standing Centre Lane (308 Rifle)									
NA	NA	NA	NA	NA	NA	NA	64	NA	NA
Prone Right Lane (308 Rifle)									
NA	NA	NA	NA	NA	NA	NA	NA	62	62
Standing Right Lane (308 Rifle)									
NA	NA	71	70	NA	NA	66	XW	70	64

- X = Audible but not measurable in ambient (background noise level or birds)  
 XW = Audible but not measurable due to wind at time of shot  
 XR = Not measurable due to extraneous noise from vehicle or plane  
 ( ) = Extraneous peak level  
 - = No measurement  
 NA = Not audible



## **APPENDIX C: Measurement Results (50 metre range test)**

### **Measurement Location A1 – Rocky Waterholes Road**

Standing Centre Lane of Range 5 (9 mm Pistol)									
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Standing Centre Lane of Range 4 (9 mm Pistol)									
NA	NA	NA	XR (66)	59	60	61	NA	XW (74)	NA
Standing Centre Lane of Range 3 (9 mm Pistol)									
NA	NA	NA	NA	NA	58	XW (71)	NA	58	60
Standing Centre Lane of Range 2 (9 mm Pistol)									
NA	NA	NA	NA	NA	NA	NA	61	55	55
Standing Centre Lane of Range 1 (9 mm Pistol)									
NA	XR (65)	57	54	55	XW (68)	XW (70)	X	XW (64)	62

### **Measurement Location A4A**

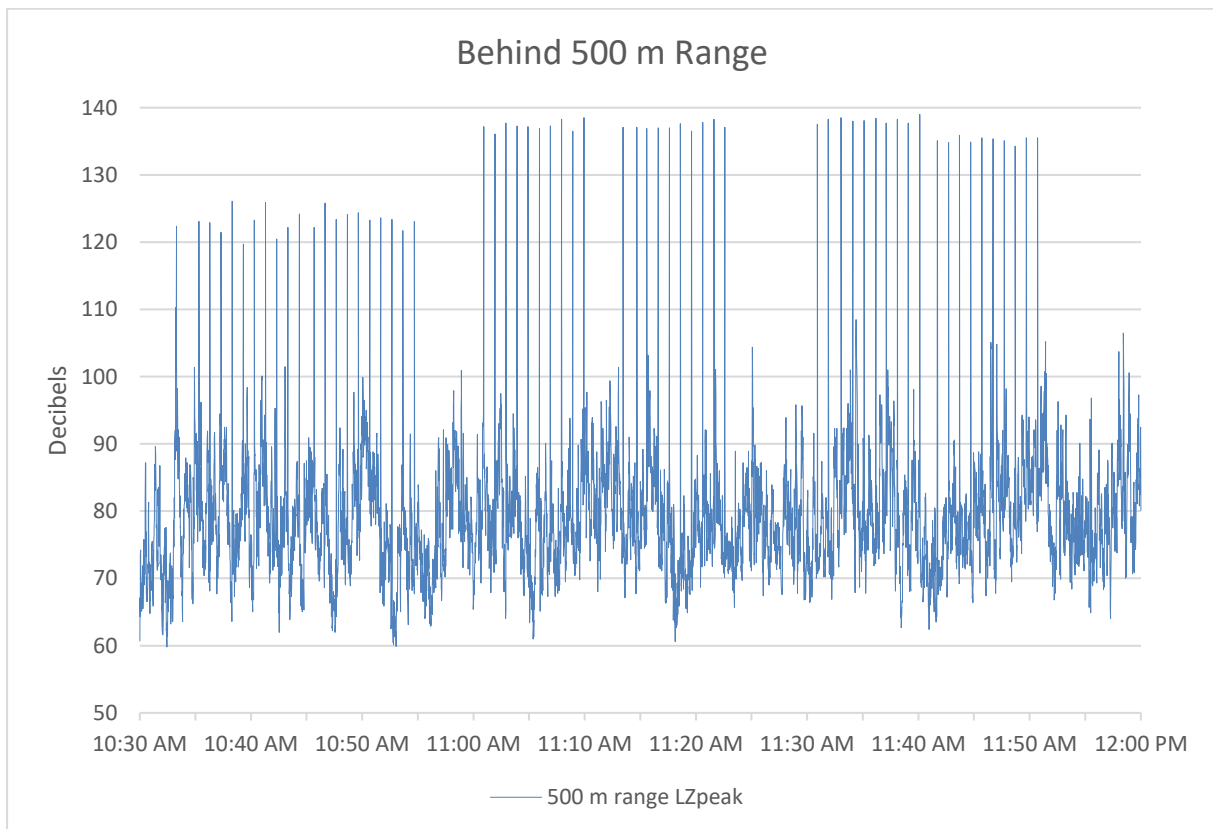
Standing Centre Lane of Range 5 (9 mm Pistol)									
X (<60)	NA	61	X (<60)	XR	63	65	65	NA	NA
Standing Centre Lane of Range 4 (9 mm Pistol)									
NA	NA	NA	NA	NA	NA	61	NA	X (<60)	61
Standing Centre Lane of Range 3 (9 mm Pistol)									
59	61	NA	NA	NA	NA	60	NA	NA	NA
Standing Centre Lane of Range 2 (9 mm Pistol)									
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Standing Centre Lane of Range 1 (9 mm Pistol)									
NA	NA	NA	NA	NA	X (<60)	58	NA	XR	XR

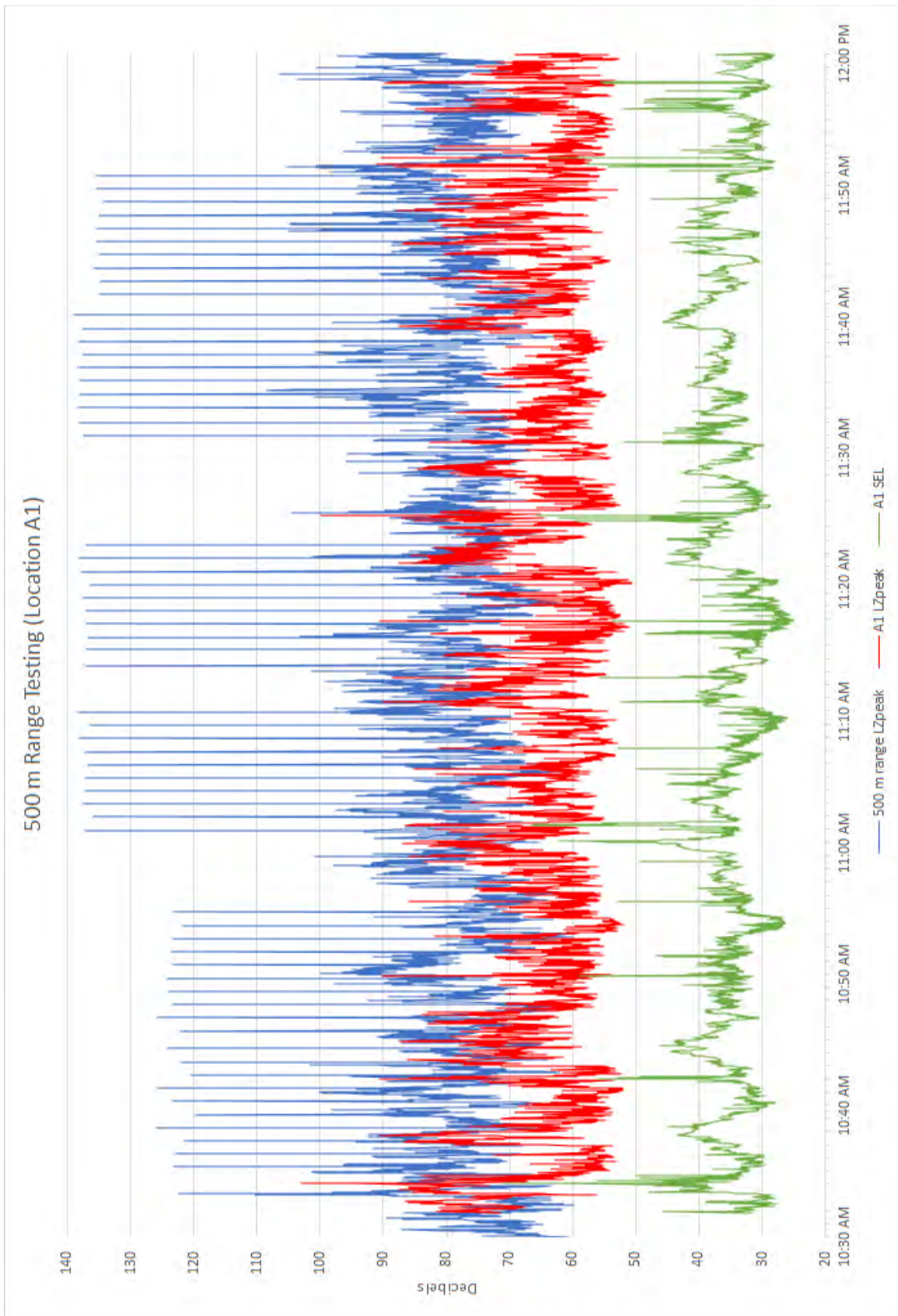
X	=	Audible but not measurable in ambient (background noise level or birds)
XW	=	Audible but not measurable due to wind at time of shot
XR	=	Not measurable due to extraneous noise from vehicle or plane
( )	=	Extraneous peak level
-	=	No measurement
NA	=	Not audible

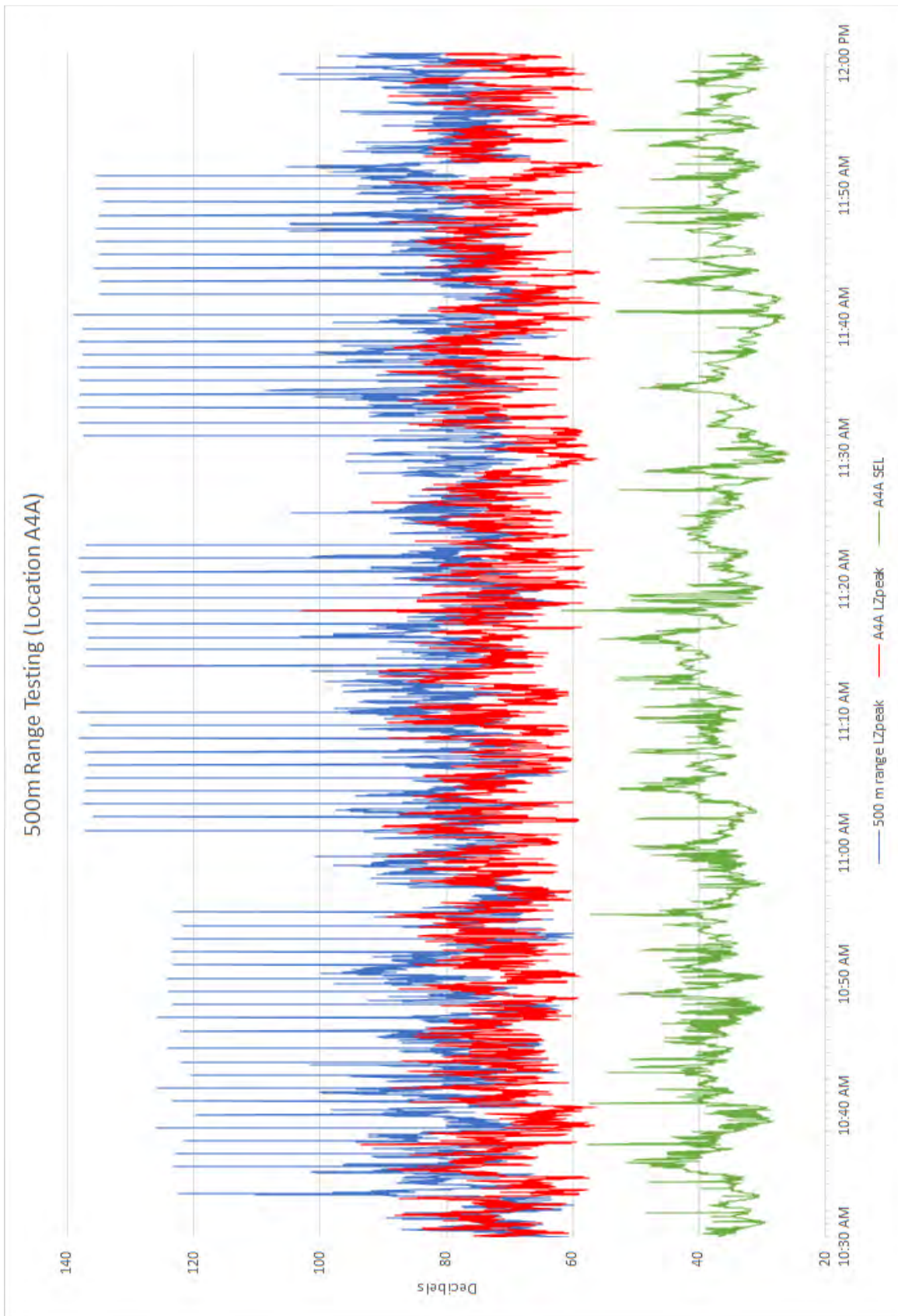


**APPENDIX D: 500 m Shooting Range (on-site) Measurement Results**

123	123	122	126	120	123	126	121	122	124
122	126	123	124	124	123	124	123	122	123
137	136	138	137	137	137	137	138	137	139
137	137	137	137	137	138	137	138	138	137
138	138	139	138	138	138	138	138	138	139
135	135	136	135	136	135	135	134	136	136



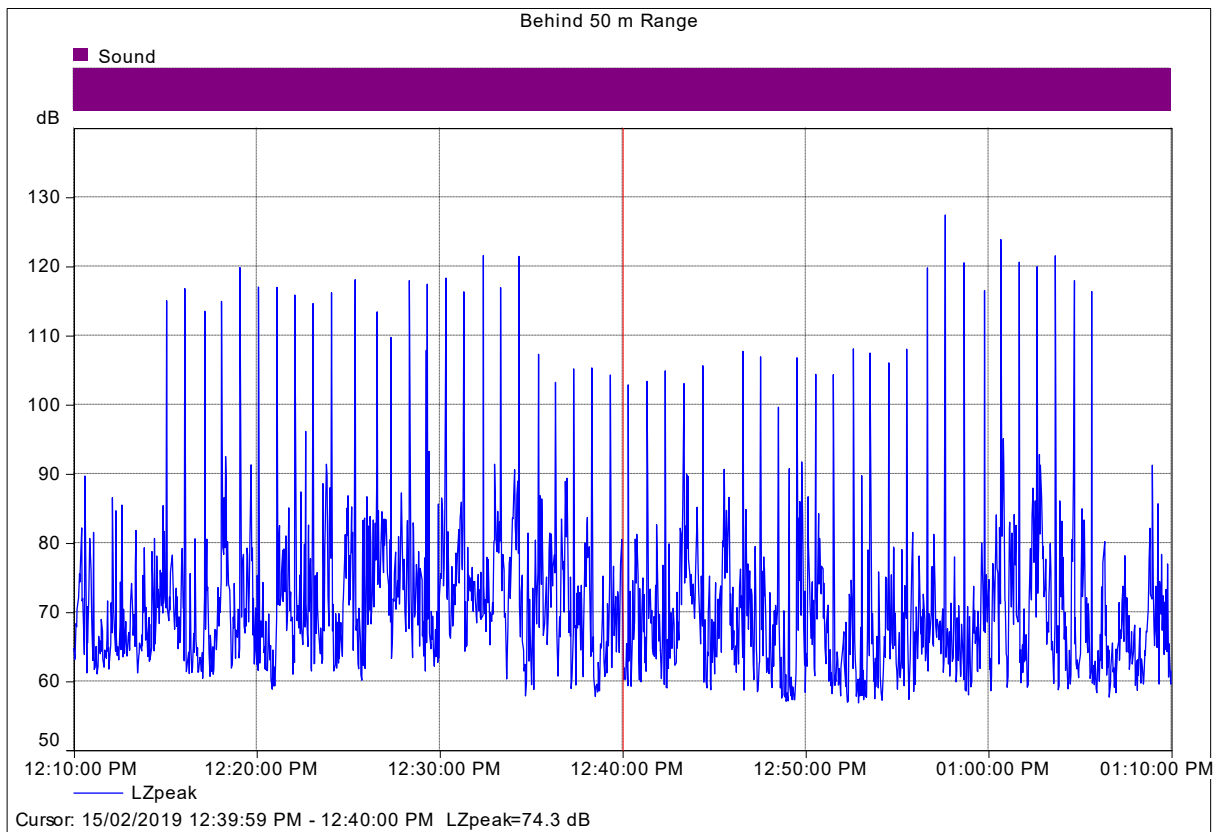


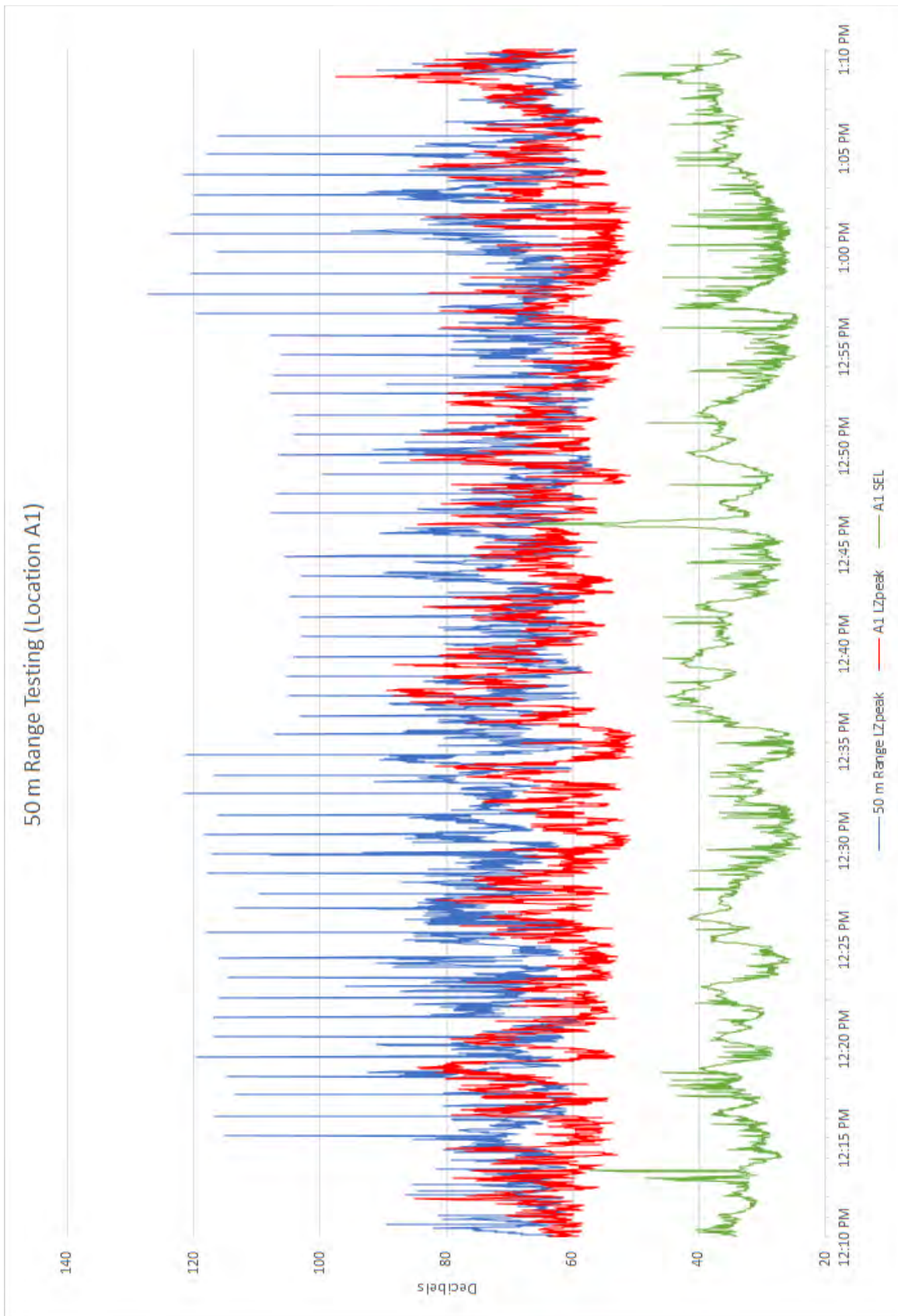


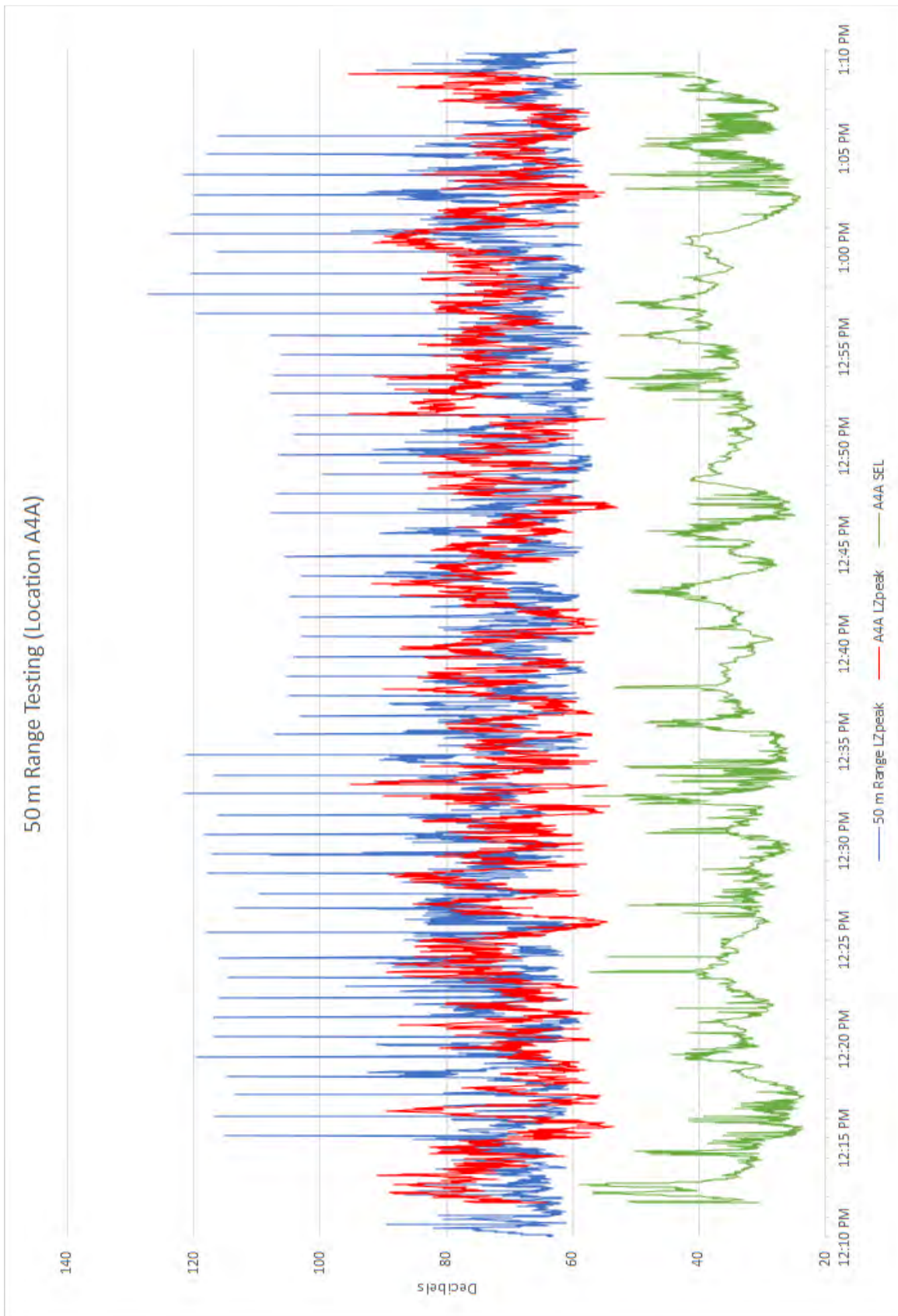


**APPENDIX E: 50 m Shooting Range (on-site) Measurement Results**

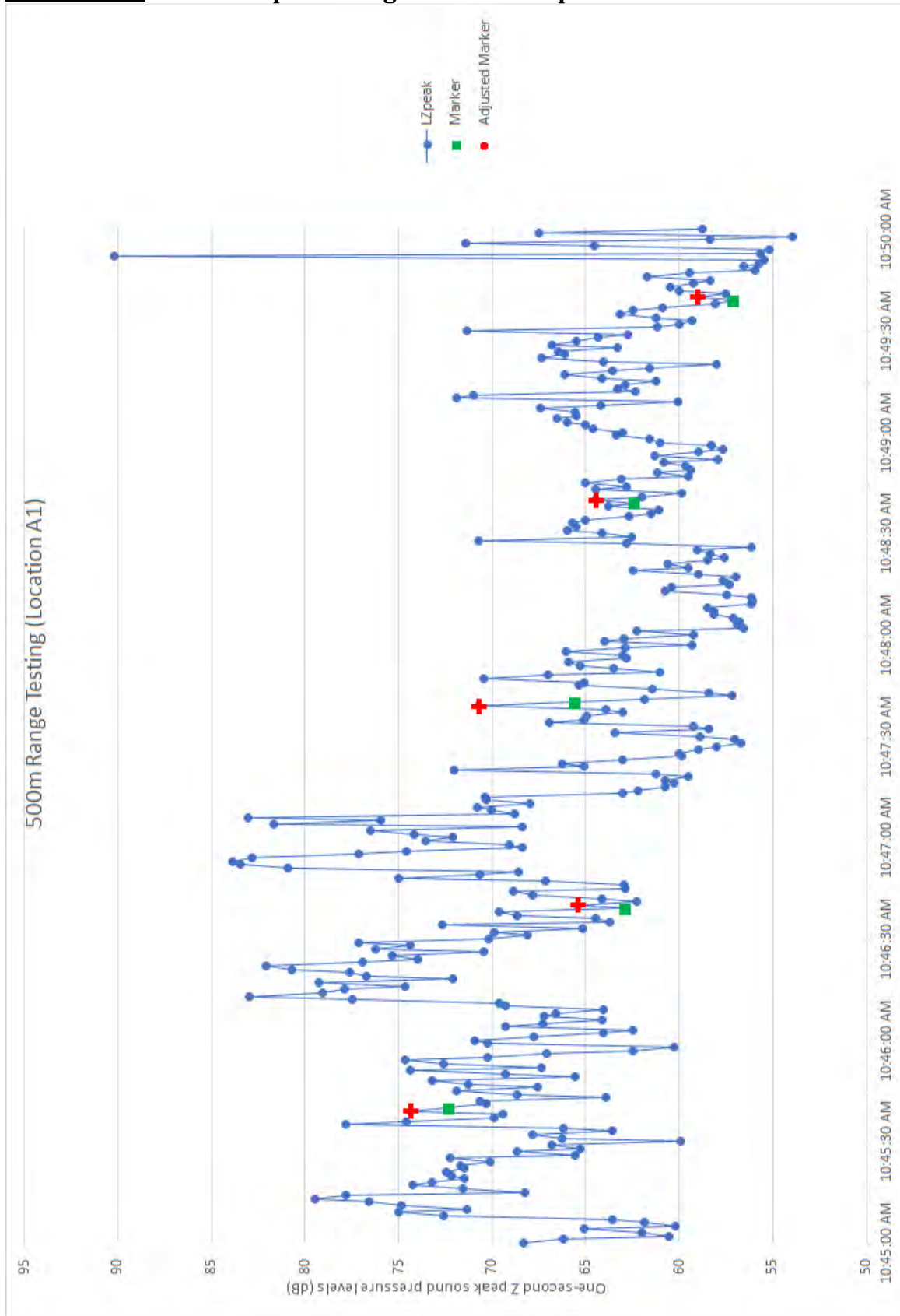
115	117	113	115	120	117	117	116	115	116
118	113	110	118	117	118	116	122	117	121
107	103	105	105	104	103	103	105	103	106
108	107	100	107	104	104	108	107	106	108
120	127	121	117	124	121	120	122	118	116







### APPENDIX F: EPA Post-processing Method Example



### Location A1 – 500 metre Range Testing

Measurement	Pre-shot LZpeak	Shot LZpeak	Shot/pre-shot difference	Shot category
Prone Left Lane (308 Rifle)				
1	55.4	62.1	6.7	A
2	61.1	58.8	-2.3	Not Valid
3	77.7	78.0	0.3	Not Valid (wind)
4	62.7	65.4	2.7	B
5	56.9	64.7	7.8	A
6	59.7	57.1	-2.6	Not Valid
7	52.0	57.8	5.8	A
8	57.0	59.3	2.3	B
9	76.3	79.6	3.3	Not Valid (wind)
10	66.4	68.5	2.1	Not Valid (wind)
Number of Category A and B shots				5
Arithmetic average of Category A and B shots				61.9
Standing Left Lane (308 Rifle)				
11	69.4	74.4	5.0	Not Valid (wind)
12	68.7	69.7	1.0	Not Valid (wind)
13	63.9	70.7	6.8	Not Valid (wind)
14	62.4	64.5	2.1	B
15	57.1	59.0	1.9	B
16	57.3	58.6	1.3	B
17	59.5	62.7	3.2	B
18	55.7	58.6	2.9	B
19	55.3	59.6	4.3	B
20	62.2	71.1	8.9	Not Valid (dogs)
Number of Category A and B shots				6
Arithmetic average of Category A and B shots				60.5
Prone Centre Lane (308 Rifle)				
21	67.9	69.4	1.5	B
22	56.0	66.1	10.1	A
23	64.8	60.5	-4.3	Not Valid
24	65.7	68.2	2.5	B
25	62.3	60.1	-2.2	Not Valid
26	61.7	64.0	2.3	B
27	62.6	63.0	0.4	B
28	57.7	58.0	0.3	B
29	55.5	64.7	9.2	A
30	61.9	65.0	3.1	B
Number of Category A and B shots				8
Arithmetic average of Category A and B shots				64.8



Measurement	Pre-shot LZpeak	Shot LZpeak	Shot/pre-shot difference	Shot category
<b>Standing Centre Lane (308 Rifle)</b>				
31	63.9	64.7	0.8	B
32	58.1	67.2	9.1	A
33	65.9	68.4	2.5	B
34	53.3	65.5	12.2	A
35	54.7	62.5	7.8	A
36	57.3	59.3	2.0	B
37	54.1	69.4	15.3	A
38	58.3	64.3	6.0	A
39	73.8	76.3	2.5	Not Valid (wind)
40	71.9	76.4	4.5	Not Valid (wind)
Number of Category A and B shots				8
Arithmetic average of Category A and B shots				65.2
<b>Prone Right Lane (308 Rifle)</b>				
41	59.5	64.7	5.2	A
42	61.1	65.9	4.8	B
43	65.1	66.7	1.6	B
44	55.2	59.0	3.8	B
45	58.7	59.6	0.9	B
46	66.1	66.5	0.4	B
47	58.8	65.5	6.7	A
48	56.6	60.9	4.3	B
49	70.9	76.7	5.8	Not Valid (wind)
50	60.7	61.4	0.7	Not Valid (wind)
Number of Category A and B shots				8
Arithmetic average of Category A and B shots				63.6
<b>Standing Right Lane (308 Rifle)</b>				
51	59.3	61.7	2.4	B
52	56.6	61.2	4.6	B
53	59.1	66.0	6.9	A
54	61.9	63.4	1.5	B
55	74.5	78.1	3.6	Not Valid (wind)
56	62.7	62.6	-0.1	Not Valid
57	57.5	66.0	8.5	A
58	66.9	67.0	0.1	B
59	57.2	60.3	3.1	B
60	58.8	60.4	1.6	B
Number of Category A and B shots				8
Arithmetic average of Category A and B shots				63.3
Total Number of Category A and B shots				43
Arithmetic average of All Category A and B shots				63.2



### Location A1 – 50 metre Range Testing

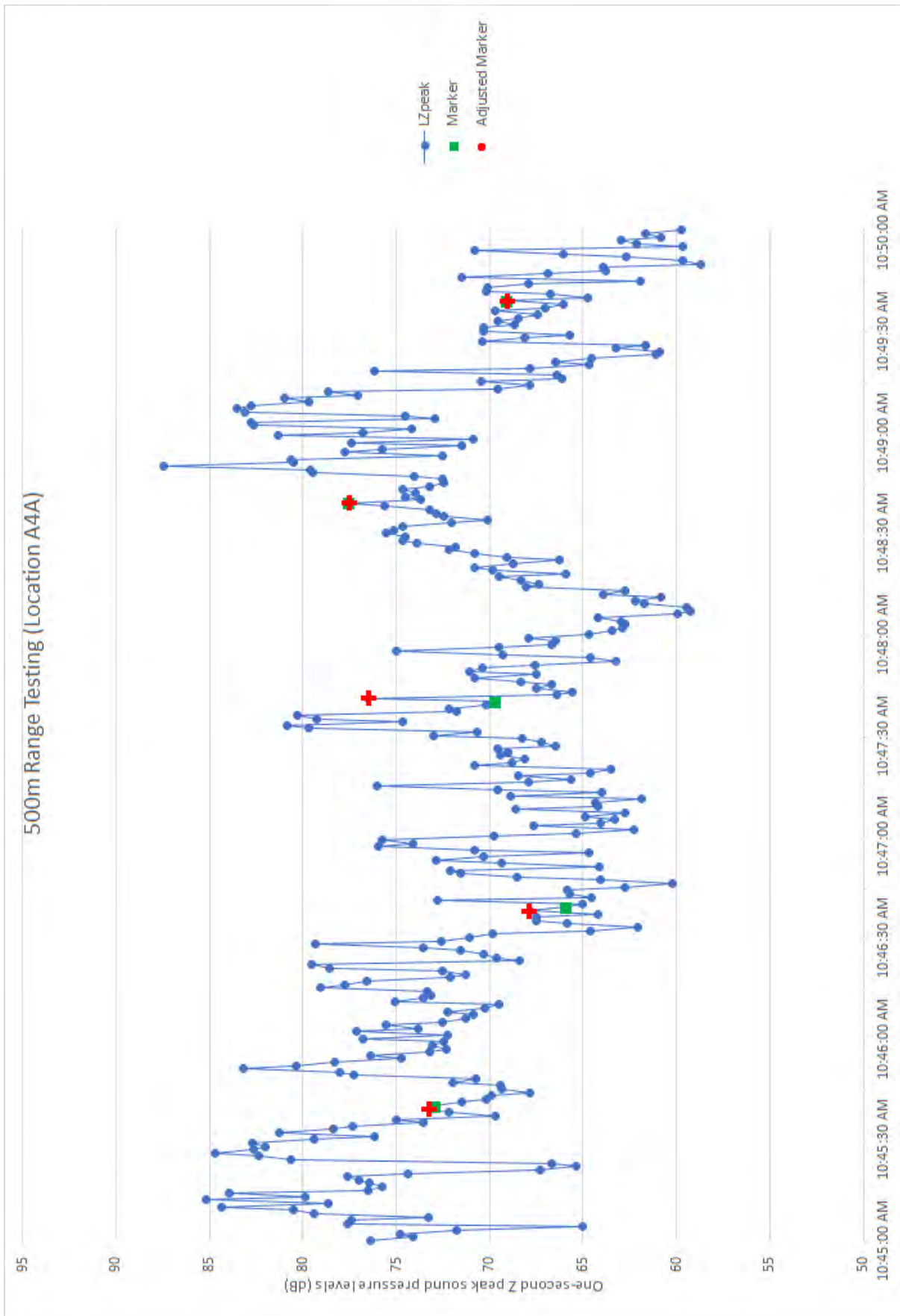
Measurement	Pre-shot LZpeak	Shot LZpeak	Shot/pre-shot difference	Shot category
Standing Centre of Range 5 (9 mm Pistol)				
1	58.4	59.2	0.8	Not Valid (inaudible)
2	59.5	73.2	13.7	Not Valid (inaudible)
3	59.5	69.8	10.3	Not Valid (inaudible)
4	63.2	70.8	7.6	Not Valid (inaudible)
5	55.0	59.1	4.1	Not Valid (inaudible)
6	70.2	73.5	3.3	Not Valid (inaudible)
7	61.0	64.9	3.9	Not Valid (inaudible)
8	58.6	55.9	-2.7	Not Valid (inaudible)
9	55.1	57.3	2.2	Not Valid (inaudible)
10	55.7	57.2	1.5	Not Valid (inaudible)
Number of Category A and B shots				0
Arithmetic average of Category A and B shots				N/A
Standing Centre of Range 4 (9 mm Pistol)				
11	60.1	62.9	2.8	Not Valid (inaudible)
12	60.7	62.5	1.8	Not Valid (inaudible)
13	56.6	59.3	2.7	Not Valid (inaudible)
14	65.8	68.1	2.3	Not Valid (plane)
15	58.0	58.1	0.1	B
16	57.9	59.5	1.6	B
17	59.9	60.6	0.7	B
18	56.8	59.2	2.4	Not Valid (inaudible)
19	70.5	73.7	3.2	Not Valid (wind)
20	52.4	54.8	2.4	Not Valid (inaudible)
Number of Category A and B shots				3
Arithmetic average of Category A and B shots				59.4
Standing Centre of Range 3 (9 mm Pistol)				
21	54.5	55.0	0.5	Not Valid (inaudible)
22	65.0	68.4	3.4	Not Valid (inaudible)
23	83.3	88.4	5.1	Not Valid (inaudible)
24	77.3	80.6	3.3	Not Valid (inaudible)
25	76.4	77.9	1.5	Not Valid (inaudible)
26	59.1	59.2	0.1	B
27	67.9	70.8	2.9	Not Valid (wind)
28	65.3	72.2	6.9	Not Valid (inaudible)
29	58.0	58.2	0.2	B
30	60.3	63.7	3.4	B
Number of Category A and B shots				3
Arithmetic average of Category A and B shots				60.4



Measurement	Pre-shot LZpeak	Shot LZpeak	Shot/pre-shot difference	Shot category
Standing Centre of Range 2 (9mm Pistol)				
31	59.0	59.6	0.6	Not Valid (inaudible)
32	60.1	64.3	4.2	Not Valid (inaudible)
33	54.3	58.4	4.1	Not Valid (inaudible)
34	71.0	72.0	1	Not Valid (inaudible)
35	74.3	71.7	-2.6	Not Valid (inaudible)
36	67.3	69.3	2	Not Valid (inaudible)
37	73.6	79.9	6.3	Not Valid (inaudible)
38	59.0	60.6	1.6	B
39	53.0	54.6	1.6	B
40	54.1	54.9	0.8	B
Number of Category A and B shots				3
Arithmetic average of Category A and B shots				56.7
Standing Centre of Range 1 (9 mm Pistol)				
41	68.8	69.4	0.6	Not Valid (inaudible)
42	60.7	65.4	4.7	Not Valid (plane)
43	55.1	54.3	-0.8	Not Valid
44	53.6	54.4	0.8	Not Valid (inaudible)
45	54.1	54.6	0.5	B
46	61.1	61.2	0.1	B
47	64.8	69.9	5.1	Not Valid (wind)
48	59.0	58.1	-0.9	Not Valid
49	64.3	61.6	-2.7	Not Valid
50	56.7	62.4	5.7	A
Number of Category A and B shots				3
Arithmetic average of Category A and B shots				59.4
Total Number of Category A and B shots				12
Arithmetic average of All Category A and B shots				59.0







### Location A4A – 500 metre Range Testing

Measurement	Pre-shot LZpeak	Shot LZpeak	Shot/pre-shot difference	Shot category
Prone Left Lane (308 Rifle)				
1	78.0	84.6	6.6	Not Valid (inaudible)
2	80.2	82.4	2.2	Not Valid (inaudible)
3	72.4	81.1	8.7	Not Valid (inaudible)
4	60.2	63.1	2.9	B
5	62.9	65.7	2.8	B
6	80.8	70.7	-10.1	Not Valid
7	82.6	88.7	6.1	Not Valid (inaudible)
8	82.7	75.6	-7.1	Not Valid
9	81.5	84.1	2.6	Not Valid (inaudible)
10	66.1	69.0	2.9	B
Number of Category A and B shots				3
Arithmetic average of Category A and B shots				66.0
Standing Left Lane (308 Rifle)				
11	72.2	73.2	1.0	Not Valid (inaudible)
12	64.2	67.9	3.7	B
13	69.7	76.5	6.8	Not Valid (inaudible)
14	75.6	77.5	1.9	Not Valid (inaudible)
15	66.0	69.0	3.0	B
16	82.1	85.1	3.0	Not Valid (inaudible)
17	66.0	69.2	3.2	Not Valid (inaudible)
18	75.6	81.9	6.3	Not Valid (inaudible)
19	76.6	79.2	2.6	Not Valid (inaudible)
20	73.0	73.4	0.4	Not Valid (inaudible)
Number of Category A and B shots				2
Arithmetic average of Category A and B shots				68.5
Prone Centre Lane (308 Rifle)				
21	77.4	84.2	6.8	Not Valid (inaudible)
22	62.7	76.0	13.3	Not Valid (inaudible)
23	67.0	70.0	3.0	Not Valid (inaudible)
24	69.6	73.1	3.5	Not Valid (inaudible)
25	73.0	76.2	3.2	Not Valid (inaudible)
26	65.1	67.7	2.6	Not Valid (inaudible)
27	79.2	77.3	-1.9	Not Valid
28	79.2	89.1	9.9	Not Valid (inaudible)
29	61.4	67.5	6.1	Not Valid (inaudible)
30	64.6	66.9	2.3	Not Valid (inaudible)
Number of Category A and B shots				0
Arithmetic average of Category A and B shots				-



Measurement	Pre-shot LZpeak	Shot LZpeak	Shot/pre-shot difference	Shot category
<b>Standing Centre Lane (308 Rifle)</b>				
31	67.6	68.4	0.8	Not Valid (inaudible)
32	73.2	73.2	0	Not Valid
33	71.6	74.2	2.6	Not Valid (inaudible)
34	74.7	74.2	-0.5	Not Valid
35	80.6	83.4	2.8	Not Valid (inaudible)
36	68.2	75.0	6.8	Not Valid (inaudible)
37	69.7	72.4	2.7	Not Valid (inaudible)
38	59.2	61.6	2.4	B
39	67.6	73.3	5.7	Not Valid (inaudible)
40	73.3	74.9	1.6	Not Valid (inaudible)
Number of Category A and B shots				1
Arithmetic average of Category A and B shots				61.6
<b>Prone Right Lane (308 Rifle)</b>				
41	70.2	71.2	1.0	Not Valid (inaudible)
42	76.0	71.7	-4.3	Not Valid (inaudible)
43	74.1	78.5	4.4	Not Valid (inaudible)
44	77.2	81.1	3.9	Not Valid (inaudible)
45	75.7	76.1	0.4	Not Valid (inaudible)
46	74.3	78.4	4.1	Not Valid (inaudible)
47	68.9	72.4	3.5	Not Valid (inaudible)
48	75.2	83.1	7.9	Not Valid (inaudible)
49	61.8	66.1	4.3	B
50	62.2	64.6	2.4	B
Number of Category A and B shots				2
Arithmetic average of Category A and B shots				65.4
<b>Standing Right Lane (308 Rifle)</b>				
51	68.8	69.0	0.2	Not Valid (inaudible)
52	76.9	80.8	3.9	Not Valid (inaudible)
53	70.6	71.0	0.4	B
54	68.1	65.5	-2.6	Not Valid
55	83.1	83.2	0.1	Not Valid (inaudible)
56	76.2	79.9	3.7	Not Valid (inaudible)
57	66.2	69.6	3.4	B
58	70.2	72.5	2.3	Not Valid (wind)
59	66.6	70.7	4.1	B
60	61.2	63.9	2.7	B
Number of Category A and B shots				4
Arithmetic average of Category A and B shots				68.8
Total Number of Category A and B shots				12
Arithmetic average of All Category A and B shots				66.9



### Location A4A – 50 metre range testing

Measurement	Pre-shot LZpeak	Shot LZpeak	Shot/pre-shot difference	Shot category
Standing Centre of Range 5 (9 mm Pistol)				
1	67.0	64.6	-2.4	Not Valid
2	67.1	70.2	3.1	Not Valid (inaudible)
3	55.5	64.2	8.7	A
4	62.9	65.3	2.4	B
5	70.0	71.9	1.9	Not Valid (plane)
6	63.4	63.8	0.4	B
7	63.1	60.4	-2.7	Not Valid
8	65.6	67.5	1.9	B
9	72.8	75.0	2.2	Not Valid (wind)
10	68.0	73.9	5.9	Not Valid (wind)
Number of Category A and B shots				4
Arithmetic average of Category A and B shots				65.2
Standing Centre of Range 4 (9 mm Pistol)				
11	69.9	71.8	1.9	Not Valid (inaudible)
12	68.2	72.8	4.6	Not Valid (inaudible)
13	62.8	65.5	2.7	Not Valid (inaudible)
14	82.9	86.6	3.7	Not Valid (inaudible)
15	76.6	80.3	3.7	Not Valid (inaudible)
16	60.0	61.4	1.4	Not Valid (inaudible)
17	66.5	66.8	0.3	B
18	73.5	70.8	-2.7	Not Valid
19	74.4	71.8	-2.6	Not Valid
20	59.1	61.4	2.3	B
Number of Category A and B shots				2
Arithmetic average of Category A and B shots				64.1
Standing Centre of Range 3 (9 mm Pistol)				
21	58.5	59.2	0.7	B
22	65.7	67.0	1.3	B
23	69.1	69.7	0.6	Not Valid (inaudible)
24	79.1	80.9	1.8	Not Valid (inaudible)
25	80.2	80.7	0.5	Not Valid (inaudible)
26	68.0	70.4	2.4	Not Valid (inaudible)
27	60.9	64.1	3.2	B
28	70.4	78.3	7.9	Not Valid (inaudible)
29	74.6	78.7	4.1	Not Valid (inaudible)
30	71.5	76.6	5.1	Not Valid (inaudible)
Number of Category A and B shots				3
Arithmetic average of Category A and B shots				63.4



Measurement	Pre-shot LZpeak	Shot LZpeak	Shot/pre-shot difference	Shot category
Standing Centre of Range 2 (9 mm Pistol)				
31	64.3	64.7	0.4	Not Valid (inaudible)
32	73.7	79.1	5.4	Not Valid (inaudible)
33	74.6	75.6	1.0	Not Valid (inaudible)
34	71.2	74.6	3.4	Not Valid (inaudible)
35	65.6	68.1	2.5	Not Valid (inaudible)
36	74.8	76.3	1.5	Not Valid (inaudible)
37	80.9	82.4	1.5	Not Valid (inaudible)
38	79.6	83.1	3.5	Not Valid (inaudible)
39	78.8	76.3	-2.5	Not Valid
40	78.3	78.6	0.3	Not Valid (inaudible)
Number of Category A and B shots				0
Arithmetic average of Category A and B shots				-
Standing Centre of Range 1 (9 mm Pistol)				
41	72.7	78.0	5.3	Not Valid (inaudible)
42	68.1	69.6	1.5	Not Valid (inaudible)
43	73.7	77.1	3.4	Not Valid (inaudible)
44	69.9	81.6	11.7	Not Valid (inaudible)
45	84.9	87.8	2.9	Not Valid (inaudible)
46	78.7	78.4	-0.3	Not Valid
47	56.2	57.9	1.7	B
48	78.0	83.8	5.8	Not Valid (inaudible)
49	69.8	72.4	2.6	Not Valid (inaudible)
50	60.1	64.5	4.4	Not Valid (inaudible)
Number of Category A and B shots				1
Arithmetic average of Category A and B shots				57.9
Total Number of Category A and B shots				10
Arithmetic average of All Category A and B shots				63.7

