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4th December, 2015

The Acoustic Group
CONSULTING ACOUSTICAL & VIBRATION ENGINEERING

Office of Sport
Sport and Recreation
Locked Bag 1422
SILVERWATER NSW 2128

Attention: Ms R. Ginger

500 METRE AND 800 METRE RANGE TESTING
SOUTHERN HIGHLANDS REGIONAL SHOOTING CENTRE
WATTLE RIDGE ROAD, HILL TOP

The purpose of this report is to present the results of acoustic testing of attenuation barrier constructions/locations carried out in relation to the 500 metre and 800 metre range at the Southern Highlands Regional Shooting Centre.

The Southern Highlands Shooting Complex is required under conditions of consent from the Minister of Planning to satisfy noise limits and undertake annual acoustic compliance monitoring at or near residential receivers of noise emission from the existing rifle range.

Testing of the effectiveness of alternative barrier constructions/locations on the 500 metre range and 800 metre range at the Southern Highlands Regional Shooting Centre was previously conducted in August 2014. During the August 2014 testing, a period of excessive wind occurred which adversely affected some of the measurement results. As a result, testing was undertaken on Saturday 10th October to retest the specific tests that had been adversely affected on the previous occasion.

The retesting to evaluate alternative barriers/enclosures was conducted using the same protocols as for previous noise control tests, using factory ammunition with the known noisiest firearms. The retesting is part of the investigation to assess exposed firing locations and shielded firing locations for both ranges.

Consistent with previous testing the results are presented as arithmetic and as absolute measurement.

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Similarly to the previous testing in August 2014, the purpose of the retesting carried out on Saturday 10th October 2015 was to test the effectiveness of various barriers and enclosures at nominated shooting positions (200 metres and 300 metres) for the 800 metre range and the 500 metre position on the 500 metre range. The testing for the 500 metre range occurred prior to testing on the 800 metre range.

The testing involves monitoring at reference residential locations. A request was made prior to retesting for measurements to be conducted at residential locations A1A, B2A and A4B. Access was not available to Location A1A thereby resulting in the use of the external location A1 in Rocky Waterholes Road.

In attendance in Rocky Waterholes Road (Location A1) and Starlight Place (Location B2A) during our monitoring of the 500 metre range and the specific 800 metre range tests were resident observers.

The resident observer at Location B2A was stationed behind the monitoring personnel and did not cause disturbance to the monitoring of levels.

However at Rocky Waterholes Road (Location A1), there were two observers seated approximately 3 – 5 metres from the monitoring microphone and whilst requested to be quiet, talked throughout the 500 metre range testing. For the 800 metre range testing, the resident observers were seated closer to the monitoring microphone than the 500 metre range testing and whilst not talking continuously, did talk during the testing. The acoustic environment at the monitoring location during the specific testing was subject to extraneous noise from road traffic, aircraft, chainsaws/grass cutters, motor vehicles and people that affected the measurements. As a result of the presence of observers at the Rocky Waterholes Road Location A1 there was interference with the monitoring results by reason of the observers generating noise in the vicinity of the microphone, by talking, rustling of pages and the movement of the chair for the seat of the observers.

The interference from the observers at Location A1 has necessitated a detailed post-processing analysis being undertaken to obtain valid results.

On arrival to the manager's residence at A4B, the operation of mechanical plant on the manager's premises could be detected and was found to affect the acoustic environment of the area. As a result, monitoring of the 500 metre range testing occurred at the residential boundary location A4A (next to the public carpark) which has been used for previous testing. After the 500 metre range tests were completed, a resident attended the monitoring personnel and requested the equipment to be moved to the rear yard of the main residence at A4B. Relocation of the equipment resulted in the first two 800 metre range (200 metre firing position) tests not being recorded. The resident observer at Location A4B was located immediately behind the TAG monitoring personnel during the 800 metre range testing and did not cause any disturbance.

Due to the characteristics of a pressure wave from an explosion, noise measurements of rifle shooting 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 previously. The EPA have now issued the document *Target Shooting Ranges: Application Note for Assessing Noise Compliance* which identifies the use of arithmetic average.

The presence of calm wind conditions 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, measurements were conducted as attended measurements, with unattended measurements at Location A1, A4A and A4B for backup/supplementary analysis.

Attended sound level measurements at the residence identified in Appendix A as A1 used a Bruel & Kjaer Modular Sound Level Meter Type 2260 (S/N 1772289). Additional unattended measurements at this residence were conducted (as a backup) using a SVAN 979 Sound Level Meter (S/N 35808).

Attended sound level measurements at Location B2A were carried out utilising a Bruel & Kjaer Modular Sound Level Meter Type 2260 (S/N 2274764).

Attended sound level measurements at the residential property to the west of the range (Locations A4A and A4B) used a Bruel & Kjaer Modular Sound Level Meter Type 2260 (S/N 1824813) with a SVAN 957 Sound Level Meter (S/N 23806) for backup.

Attended measurements to the rear of the firing positions on the 500 metre range and the 800 metre range were conducted using a Bruel & Kjaer Sound Level Meter Type 2250 (S/N 3004338) and for backup, a SVAN 957 Sound Level Meter (S/N 15364).

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 standards traceable (externally or internally) 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.

Measurement Procedures

Previous measurements related to the subject range have involved different locations used for assessing the noise.

For the October 2015 testing, monitoring was undertaken on two of the residential properties in an exposed location within the 30 metre envelope of the dwelling (Location A4B and B2A), whilst Locations A1 and A4A are outside the relevant residential property.

It is noted that the monitoring at Location A1 was subject to interference from extraneous noise such as powered gardening tools (chainsaws and grass cutters), resident observers talking in proximity to the microphone, and vehicles.

For the residence south of Location B2, monitoring was conducted at Location B2A which was to the north-east of the dwelling (on the range side of the dwelling) at the extent of the 30 metre envelope boundary.

Location A4A was utilised for monitoring of the 500 metre range testing so as to be away from the influence of mechanical plant. Following the resident's request to relocate the monitoring of the shooting centre to the rear yard of the main residence, the 800 metre range testing was conducted at Location A4B but missed the first two tests at the 200 metre firing position (due to the process of relocation).

Appendix A identifies the measurement locations in the residential areas, with Appendix A2 and A3 highlighting the locations for A1 and B2 by expanded views.

The program for the 500 metre range test nominated 50 shots from a prone position at 20 second intervals. Change of shooter and firearm occurred after each batch of 10 shots.

The testing utilised the fabricated temporary acoustic shelter at the lowered shooting position (at natural ground level) of the 500 metre range.

For all of the shots in relation to testing of the 500 metre range, noise levels were monitored at a position to the rear and side of the firing positions on the elevated platform (outside the existing structure) so as to identify the consistency in the noise levels generated during shooting.

The program for the 800 metre range test nominated 5 shots for different scenarios at 20 second intervals. The testing of the 800 metre range commenced with the shooting fired from the 200 metre position and then a second set of tests at 300 metre position. Appendix B sets out a program of the testing that was carried out for the 800 metre firing range.

For all of the individual tests identified in Appendix B noise levels on the 800 metre range were monitored at a position behind and to the side of the firing positions so as to identify the generation of a shot for post processing timing purposes.

Whilst for each test the location behind the firing position provides a range of noise levels to confirm shooting had occurred, caution is needed in comparing the individual levels (or the average levels) between the tests for the same nominal firing distance and different lane/firing position scenario. Because the microphone behind the firing position was at a stationary location the relationship of the firing position to the microphone can change for each of the different test scenarios by reason of distance and shielding from the temporary barriers/enclosures.

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 each location manually writing down the results (including any obvious 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 and/or extraneous noise if present at the same time of the shot, or shortly thereafter.

Because the Peak Hold level is a measurement parameter that has no frequency weighting, and 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 measureable 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 measureable 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 the wind. Hence the desire to have supplementary back-up recording of the measurements for post processing and determination if the wind affected the results.

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 and then undertake post-processing analysis (where possible) to verify the shots in the environment in which they occur.

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. The second step utilises the post-processing analysis discussed in the following section.

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

Post-Processing Analysis

Appendices C, E and G provide a table of measurement results for the on-site observations and the post-processed results for the specific testing program.

From measurements of shot noise using the manual method, it has been found that shots can be inaudible or audible but cause no measureable increase above the ambient level at the residential locations, as a result of the distance to the shooting range as well as extraneous noise at the residential receivers masking the noise of the shots.

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 differences in the instrument clock times as well as the sound delay due to the speed of sound and the distance between the shooting range and the residential locations.

The process of time synchronising the instruments concentrated on the results from the 500 metre range test and the specific tests on the 800 metre range, as the shots occurred at a regular interval (20 seconds) and are therefore easier to identify than for general compliance test.

With respect to post processing, the NSW EPA document *Target Shooting Ranges: Application Note for Assessing Noise Compliance* 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 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 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 shot 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”).

In undertaking the EPA post-processing method the measurement results from Location A4A have been utilised to present an example as this residential monitoring location had less interference from extraneous noise sources (no grass cutters, no interference from resident observers and no vehicles, etc.) than residential monitoring location A1. The time splice graph in Appendix I1 is set out in the same format as the example in the EPA’s Application Note and shows the first 5 minutes of the 500 metre range testing, as an expanded view of the measurement results that clearly show the timing of the shots and the relevant peak levels.

The blue line of the time splice graph represents the LZpeak levels recorded at Location A4A with green markers superimposed onto the graph to identify the occurrence of a shot. 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.

Appendix I2 provides a table of the measurement results from Appendix F1 presented in the format of the example in the EPA’s Application Note for completeness.

Appendix I3 provides the measurement results from the same time and location period as the graph in Appendix I1 but with the addition of the on-site testing shots (shown as a green graph) that permits one to align the individual shots.

An additional tool that assists in post-processing to eliminate general extraneous noise is the addition of the purple time splice graph which is the A-weighted SEL level at the residential monitoring location.

Measurement Results

Appendices C, E and G provide a table of the results of the measurements in relation to the shots fired on the 500 metre range, 800 metre range at the 200 metre position and 800 metre range at the 300 metre position respectively.

In accordance with the EPA Application Note and the relatively low levels from the shots, the TAG monitoring personnel observations have been compared to the time splice charts (identified as data file in Appendices C, E and G) to determine the validity of the measured levels.

Unfortunately, the resident observers present at Location A1 carried out conversations throughout the 500 metre range testing (despite a request to be quiet) leading to the TAG monitoring personnel only being able to detect a small number of shots that under the EPA procedures would show clear compliance and general inaudibility.

Utilising the post processing method for time aligning for shots generated on the range the data file results provide a few additional measurements. For Location A4A, A4B and B2A, there is general agreement between the field observations and the data file.

For the 500 metre range test, only the results for Location B2A identified a few shots affected by wind, whilst for the specific tests of the 800 metre range, there was a greater presence of wind at the three residential monitoring locations.

From the material in Appendices C, E and G and utilising the timing for recorded measurements at the residential locations, adjustments for the difference between the on-site shot time and the recorded time at each residential receiver is determined. For the post-processing analysis the recorded measurements behind the firing positions are superimposed on the graphical results from the receiver location measurements with the appropriate timing correction to permit synchonisation of the actual shot and identification of extraneous noise that is not associated with the shot.

Appendices D, F and H provides a series of time splice graphs for the 500 metre range testing, 800 metre range testing at the 200 metre firing position and 800 metre range testing at the 300 metre firing position respectively. The time splice graphs show the on-site measurements relative to each residential measurement with the residential location time shifted to align with the on range measurements.

The time splice graphs present the peak level (LZpeak) and A-weighted Sound Exposure Level (1 second), in red and green respectively, at the various residential monitoring locations for the periods that cover the 500 metre range testing and specific tests at the 800 metre range.

The red graphs show a significant proportion of the peak levels do not align with shots. The fluctuations in the average minimum level in the red graph identify the presence of extraneous noise.

The green graphs are able to show audible noise events associated with extraneous noise sources such as cars, planes and grass cutters/chainsaws.

Comparing the red and green graphs allows the identification of an increase in the general trend of the peak hold level that is not attributed to audible extraneous noise but applies to the light intermittent wind.

Superimposed onto the graphs is the LZpeak level that was recorded behind the firing positions (blue graph). The timings of the measurement results at the residential locations have been adjusted to coincide with the timing of the on-site measurements so as to identify the occurrence of a shot.

Whilst the occurrence of a shot can easily be identified in the time splice graph of the on-site measurement due to the peak level (LZpeak) of the shot being, on average, 129 dB and much greater than the ambient level, the distance attenuation of the shot to residential receivers results in the noise level of the shot being at times in the same order of magnitude or lower than that of the ambient noise.

This is illustrated in the graphs by the occurrence of ambient peak levels (LZpeak) at the residential monitoring locations greater than the peaks that coincide with shots fired in 20 second intervals as identified by the timing from the on-site measurement results.

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.

500 Metre Range Test Analysis

At Location A1, the majority of the 500 metre range test monitoring was subject to interference from extraneous noise sources such as talking from the resident observers, vehicle movements on Rocky Waterholes Road, and the operation of powered gardening implements from residences near the monitoring location. As a result, only three shots from the 500 metre range testing were detected by the monitoring personnel to give rise to the measured level above the ambient noise level whilst the remainder of the shots were either inaudible or audible but did not give rise to levels recorded by the observer above the ambient noise level. Taking into account the number of shots that occurred on site, the average level for the 500 metre range must be less than 62 dB(A).

At Location A4A, three planes flying overhead were observed during the monitoring of the 500 metre range test which resulted in a number of measurement results being affected by the aircraft and as such ignored. The planes can be identified in the time splice graph in Appendix F1 as the broad peaks in the LZpeak and A-weighted SEL at 11:07 AM, 11:11 AM and 11:17 AM. The arithmetic average peak level of the shots at Location A4A (observer and post processing) was determined to be 61 dB which is consistent with previous testing.

At Location B2A, the aircraft identified for Location A4A are also apparent in Appendix D3. The post processed results reveals consistency with the TAG monitoring personnel field observations with the arithmetic average peak level of the shots from field observations and post processing being 58 dB and 59 dB respectively.

The re-testing of the 500 metre range revealed residential noise levels under stable weather conditions (negligible wind) to be well under the design limit and consistent with previous testing.

From the measurement results in Appendix C the arithmetic average and the absolute peak of the unaffected individual peak hold results have been provided in the table below. The levels in parenthesis relate to post-processed results.

Table 1: 500m Range – Arithmetic Average and Absolute Peak Hold dB

Location	Peak Hold (dB)		No. of Shots	
	Arithmetic Average	Absolute	Category A	Category B
On Range	129	132	-	-
A1A	62 (66)	67 (71)	3	2
B2A	58 (59)	65 (66)	1	24
A4A	61 (61)	68 (68)	12	19

800 Metre Range Test Analysis

The results of the 800 metre range testing for the 200 metre firing position is set out in Appendix E with the results of the 300 metre firing position set out in Appendix G.

For the Rocky Waterholes Road location, the resident observers created significantly less noise than during the 500 metre range testing. During the course of the monitoring it was observed a few occasions where wind was present and influenced the results.

During the monitoring, questions were raised by a resident observer as to the influence of wind on the results. Observations of the meter (as identified in the EPA monitoring advice) can show that elevated peak levels prior to and after a shot identifies the potential for wind affected results (or other extraneous noise sources). However observing the movement of leaves (that may not be audible) is a relatively simple exercise.

Appendices F and H provide the time splice graph for the 800 metre range testing using the same displaced time axis concept as for the 500 metre range testing to align the residential location measurements. Examination of the graphical results at the residential locations show that for the Z-weighed Peak Hold levels (red graph) whilst having peaks that align with some shots, also have peak levels that do not align with the shots. Such peak levels therefore relate to extraneous noise such as birds, wind and resident observers (at Location A1).

The green graphs are the A-weighted Sound Exposure Levels at 1 second increments. The green graphs are able to show audible noise events associated with extraneous noise sources such as cars, planes and grass cutters/chainsaws.

The significance of variations in the ambient noise that generate levels that are greater than that produced by shots become clearly apparent when one examines the periods of time from one shooter finishing their test shots and the next shooter commencing the next sequence of shots.

For example, using the 200 metre firing position on the 800 metre range (Appendix F) between 11:55am and 11:57am and again between 12:01pm and 12:03pm the LZpeak levels could not have been influenced by shots because there were no shots occurring.

The graphs show that when shots were not occurring there were LZpeak levels between 56 – 96 dB at Location A1 (the 96 dB peak being a bird), between 52 – 84 dB at Location A4B and between 50 – 97 dB at Location B2A, i.e. the ambient noise without any shooting occurring can easily exceed the specified limits.

From the measurement results in Appendix E and G, Table 1 sets out the arithmetic average of the tests obtained for the 200 metre and 300 metre firing positions with Table 2 showing the absolute peak level. The levels in parenthesis relate to post-processed results.

Table 2: 800m Range – Arithmetic Average Peak Hold dB

Dist. (m)	Firearm	Description of Shot	On Range (BFP)	A1A	B2A	A4B
200	308	Standing in Lane 1	130	69 (67)	57 (62)	-
200	308	Kneeling/Sitting at a Bench in Lane 1	131	62 (66)	61 (60)	-
200	308	Standing in Lane 4	127	58 (64)	62 (64)	60 (62)
200	308	Kneeling/Sitting at a Bench in Lane 4	136	63 (59)	62 (67)	66 (66)
200	308	Standing in Lane 7	125	61 (66)	61 (65)	65 (65)
200	308	Kneeling/Sitting at a Bench in Lane 7	124	- (63)	57 (60)	62 (64)
300	308	Standing in Lane 1	131	61 (66)	55 (60)	57 (57)

Dist. (m)	Firearm	Description of Shot	On Range (BFP)	A1A	B2A	A4B
300	308	Kneeling/Sitting at a Bench in Lane 1	131	66 (63)	56 (56)	63 (65)
300	308	Prone in Lane 1	131	60 (64)	56 (61)	57 (59)
300	308	Standing in Lane 4	136	62 (66)	59 (62)	62 (61)
300	308	Kneeling/Sitting at a Bench in Lane 4	129	61 (61)	60 (61)	63 (-)
300	308	Prone in Lane 4	130	60 (66)	58 (62)	63 (-)
300	308	Standing in Lane 7	129	62 (65)	57 (62)	60 (60)
300	308	Kneeling/Sitting at a Bench in Lane 7	126	- (63)	58 (55)	56 (60)
300	308	Prone in Lane 7	130	- (64)	57 (60)	59 (64)

Table 3: 800m Range – Absolute Peak Hold dB

Dist. (m)	Firearm	Description of Shot	On Range (BFP)	A1A	B2A	A4B
200	308	Standing in Lane 1	132	71 (71)	59 (64)	-
200	308	Kneeling/Sitting at a Bench in Lane 1	133	68 (69)	69 (65)	-
200	308	Standing in Lane 4	131	60 (71)	69 (69)	62 (62)
200	308	Kneeling/Sitting at a Bench in Lane 4	137	66 (59)	69 (68)	69 (69)
200	308	Standing in Lane 7	127	62 (67)	63 (68)	68 (68)
200	308	Kneeling/Sitting at a Bench in Lane 7	126	- (63)	57 (60)	62 (64)
300	308	Standing in Lane 1	132	62 (68)	56 (62)	65 (65)
300	308	Kneeling/Sitting at a Bench in Lane 1	132	66 (65)	59 (58)	65 (65)
300	308	Prone in Lane 1	133	62 (66)	60 (64)	59 (59)
300	308	Standing in Lane 4	137	64 (66)	63 (67)	67 (62)
300	308	Kneeling/Sitting at a Bench in Lane 4	130	63 (62)	68 (65)	63 (-)

Dist. (m)	Firearm	Description of Shot	On Range (BFP)	A1A	B2A	A4B
300	308	Prone in Lane 4	131	60 (69)	61 (65)	66 (-)
300	308	Standing in Lane 7	129	62 (65)	57 (62)	60 (60)
300	308	Kneeling/Sitting at a Bench in Lane 7	127	- (65)	61 (56)	58 (62)
300	308	Prone in Lane 7	130	- (67)	60 (64)	64 (67)

Table 4 sets out the number of Category A and Category B shots obtained for the specific tests of the 800 metre range utilising the EPA's post processing methodology. The first number (before the forward slash) indicates the number of Category A shots whilst the second number (after the forward slash) represents the number of Category B shots. Five shots were fired for each specific test resulting in a total of 30 shots for the specific tests at the 200 metre position, 45 shots for the specific tests at the 300 metre position and 75 shots for all specific tests of the 800 metre firing range.

Table 4: 800m Range – Number of Measureable Shots

Dist. (m)	Description of Shot	A1A	B2A	A4B
200	Standing in Lane 1	-	1/2	-/3
200	Kneeling/Sitting at a Bench in Lane 1	-	-/2	1/1
200	Standing in Lane 4	1/1	2/1	1/3
200	Kneeling/Sitting at a Bench in Lane 4	3/2	3/1	-/1
200	Standing in Lane 7	-/4	2/1	-/2
200	Kneeling/Sitting at a Bench in Lane 7	-/3	1/3	-
300	Standing in Lane 1	2/3	1/3	1/2
300	Kneeling/Sitting at a Bench in Lane 1	-/2	-/4	-/3
300	Prone in Lane 1	1/-	2/2	2/2
300	Standing in Lane 4	-/4	1/2	-/2
300	Kneeling/Sitting at a Bench in Lane 4	-	-/3	-/4
300	Prone in Lane 4	-	1/2	-/2
300	Standing in Lane 7	-/2	1/1	1/4
300	Kneeling/Sitting at a Bench in Lane 7	1/3	-/3	-/4
300	Prone in Lane 7	2/3	1/2	-/2
Total no. of measureable 200 m position shots		2/10	9/10	4/10
Total no. of measureable 300 m position shots		4/25	7/22	6/17
Total no. of measureable 800 m range specific test shots		6/35	16/32	10/27

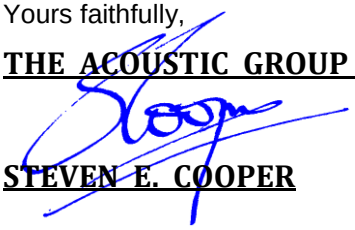
Conclusion

The retesting of the 500 metre range of Southern Highlands Regional Shooting Centre carried out on Saturday 10th October, 2015 revealed the noise level of shots to be less than the noise target of 75 dB as both an arithmetic peak level and an absolute peak level.

The results of the specific tests at the 800 metre range of Southern Highlands Regional Shooting Centre carried out on Saturday 10th October, 2015 revealed for all tests the noise level of shots to be less than the noise target of 75 dB as both an arithmetic peak level and an absolute peak level and demonstrate the effectiveness of the noise controls.

Yours faithfully,

THE ACOUSTIC GROUP PTY LTD



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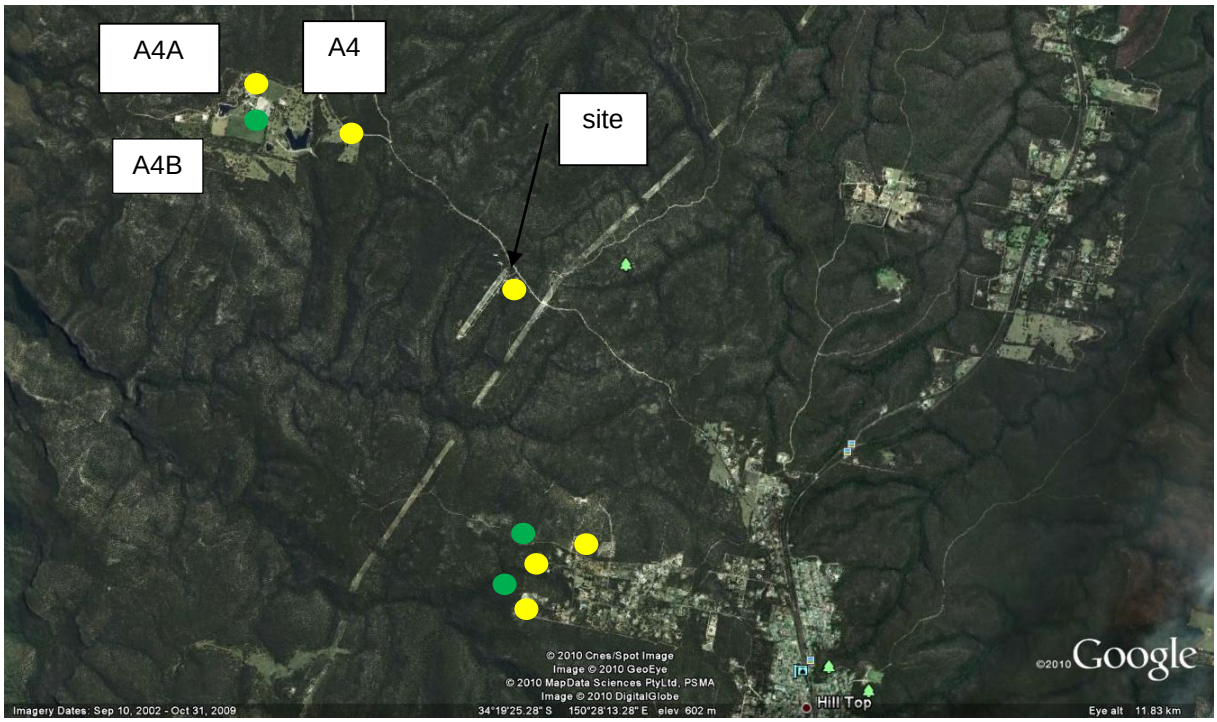
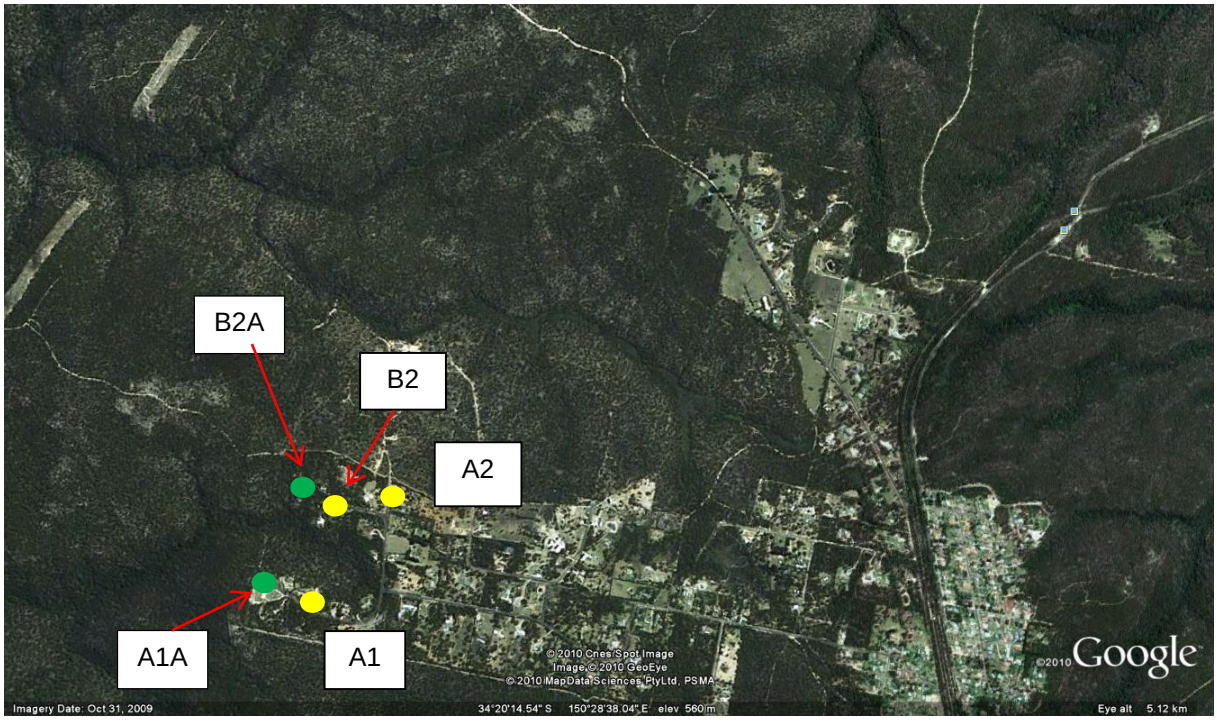
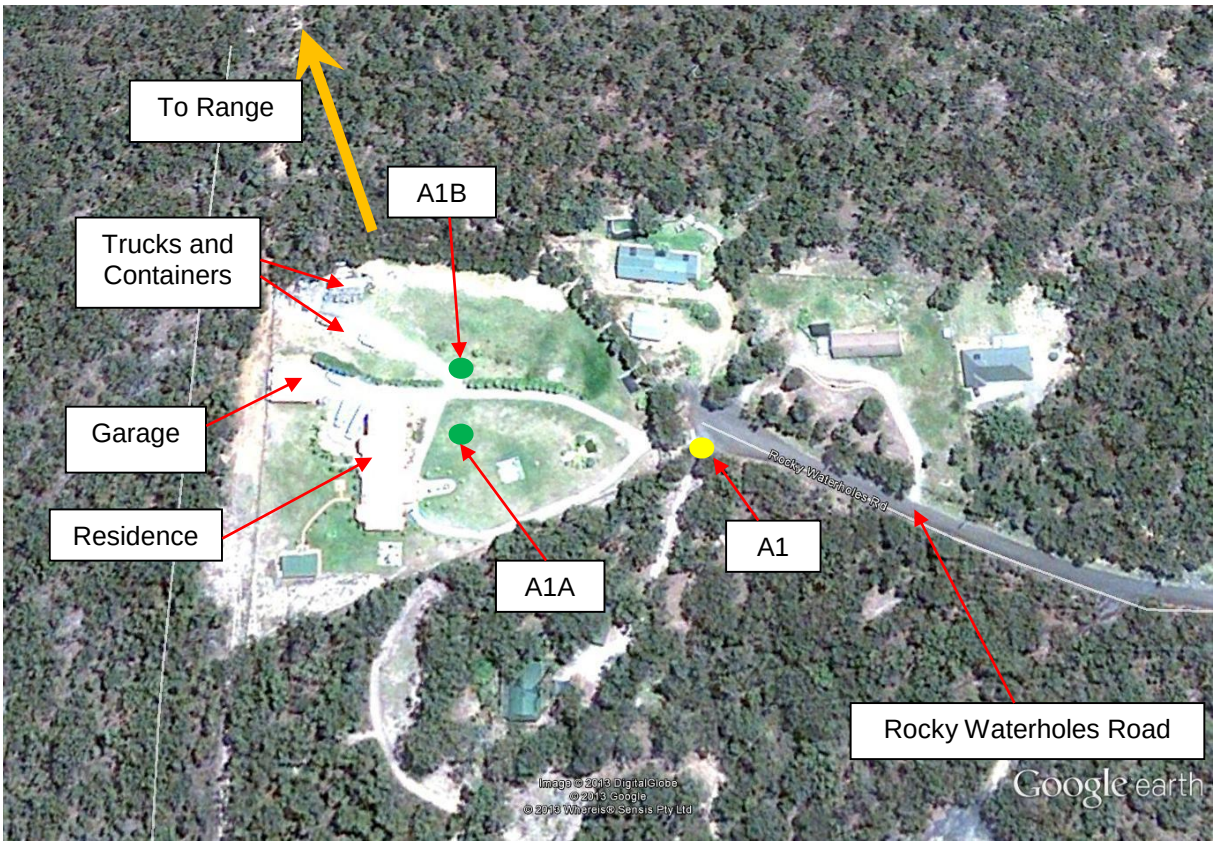
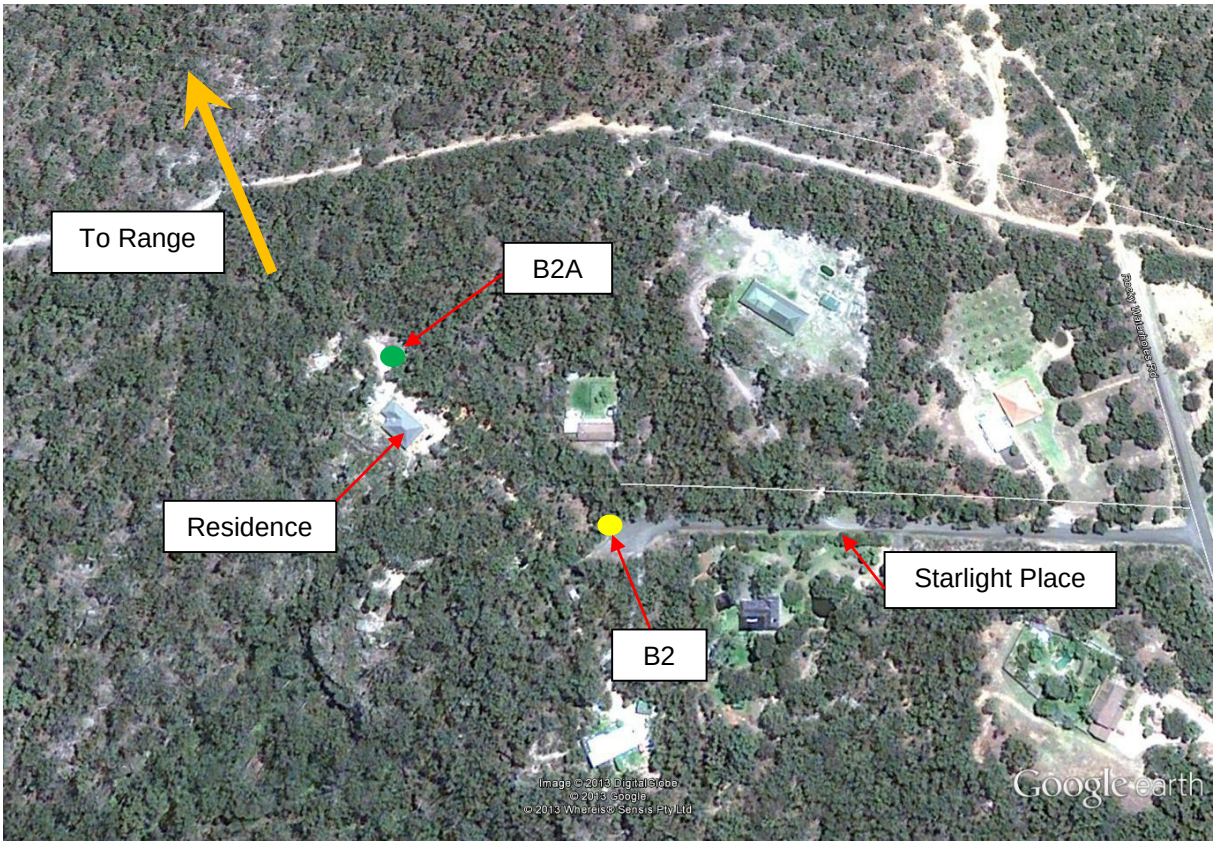
APPENDIX A: Measurement Locations




B2A
B2
A2
A1A
A1
© 2010 Cnes/Spot Image
Image © 2010 GeoEye
© 2010 MapData Sciences Pty Ltd, PSMA
©2010 Google
Imagery Date: Oct 31, 2009
34°20'14.54" S 150°28'38.04" E elev 560 m
Eye alt 5.12 km


To Range
A1B
Trucks and Containers
Garage
Residence
A1A
A1
Rocky Waterholes Rd
Rocky Waterholes Road
Image © 2013 DigitalGlobe
© 2013 Google
© 2013 Whereis® Sensis Pty Ltd
Google earth


To Range
B2A
Residence
Starlight Place
B2
Image © 2013 DigitalGlobe
© 2013 Google
© 2013 Whereis® Sensis Pty Ltd
Google earth

APPENDIX B: Measurement Program 800 Metre Range

Start Time	Firing Distance (m)	Firing Position	Firearm
11:52:02 AM	200	Standing in Lane 1	308
11:53:43 AM	200	Kneeling/Sitting at a Bench in Lane 1	308
11:57:36 AM	200	Standing in Lane 4	308
11:59:38 AM	200	Kneeling/Sitting at a Bench in Lane 4	308
12:03:02 PM	200	Standing in Lane 7	308
12:04:44 PM	200	Kneeling/Sitting at a Bench in Lane 7	308
12:15:39 PM	300	Standing in Lane 1	308
12:17:41 PM	300	Kneeling/Sitting at a Bench in Lane 1	308
12:19:41 PM	300	Prone in Lane 1	308
12:24:26 PM	300	Standing in Lane 4	308
12:26:51 PM	300	Kneeling/Sitting at a Bench in Lane 4	308
12:28:55 PM	300	Prone in Lane 4	308
12:32:04 PM	300	Standing in Lane 7	308
12:34:27 PM	300	Kneeling/Sitting at a Bench in Lane 7	308
12:36:25 PM	300	Prone in Lane 7	308

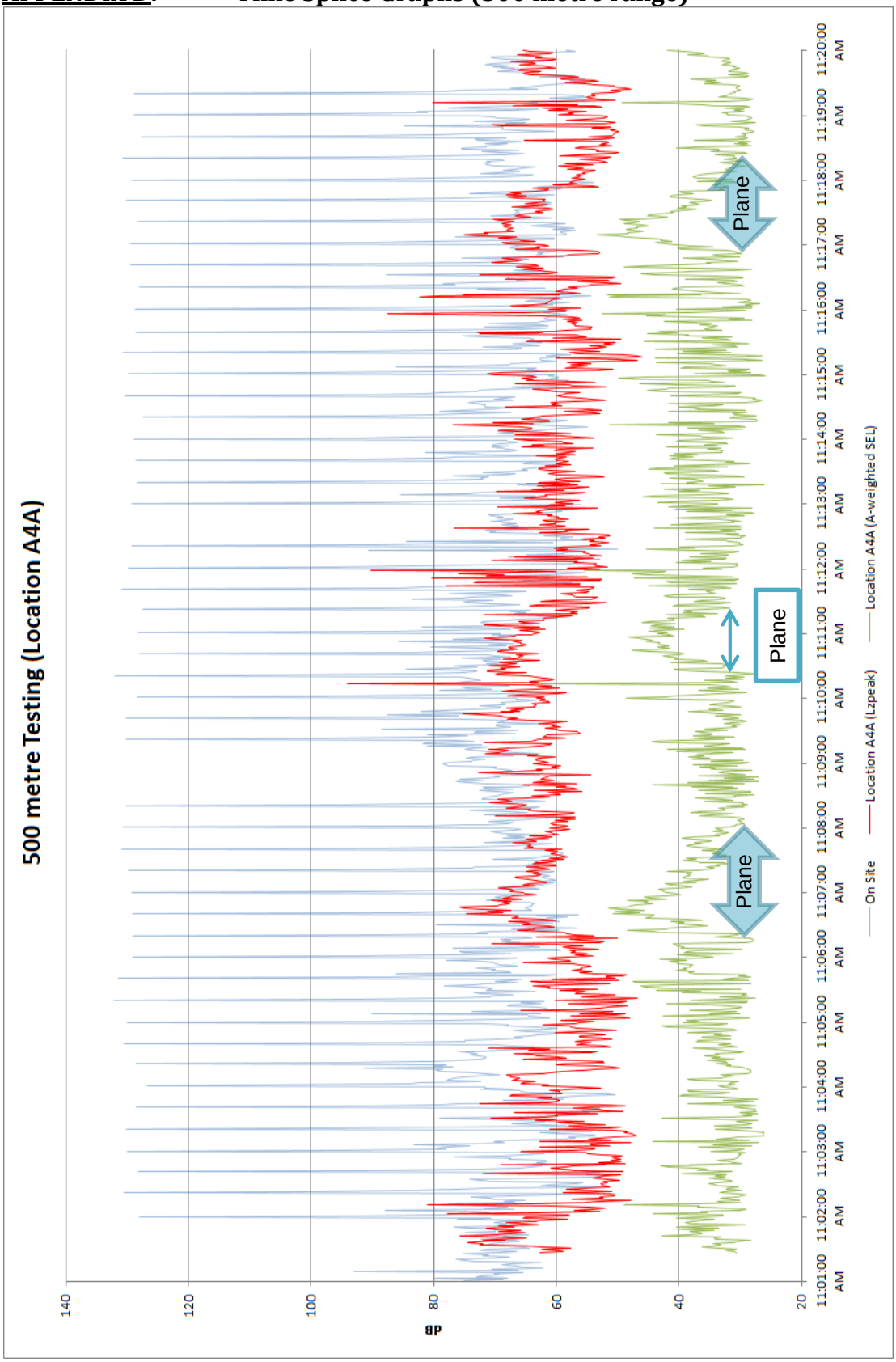
APPENDIX C: Measurement Results – For 500 metre range

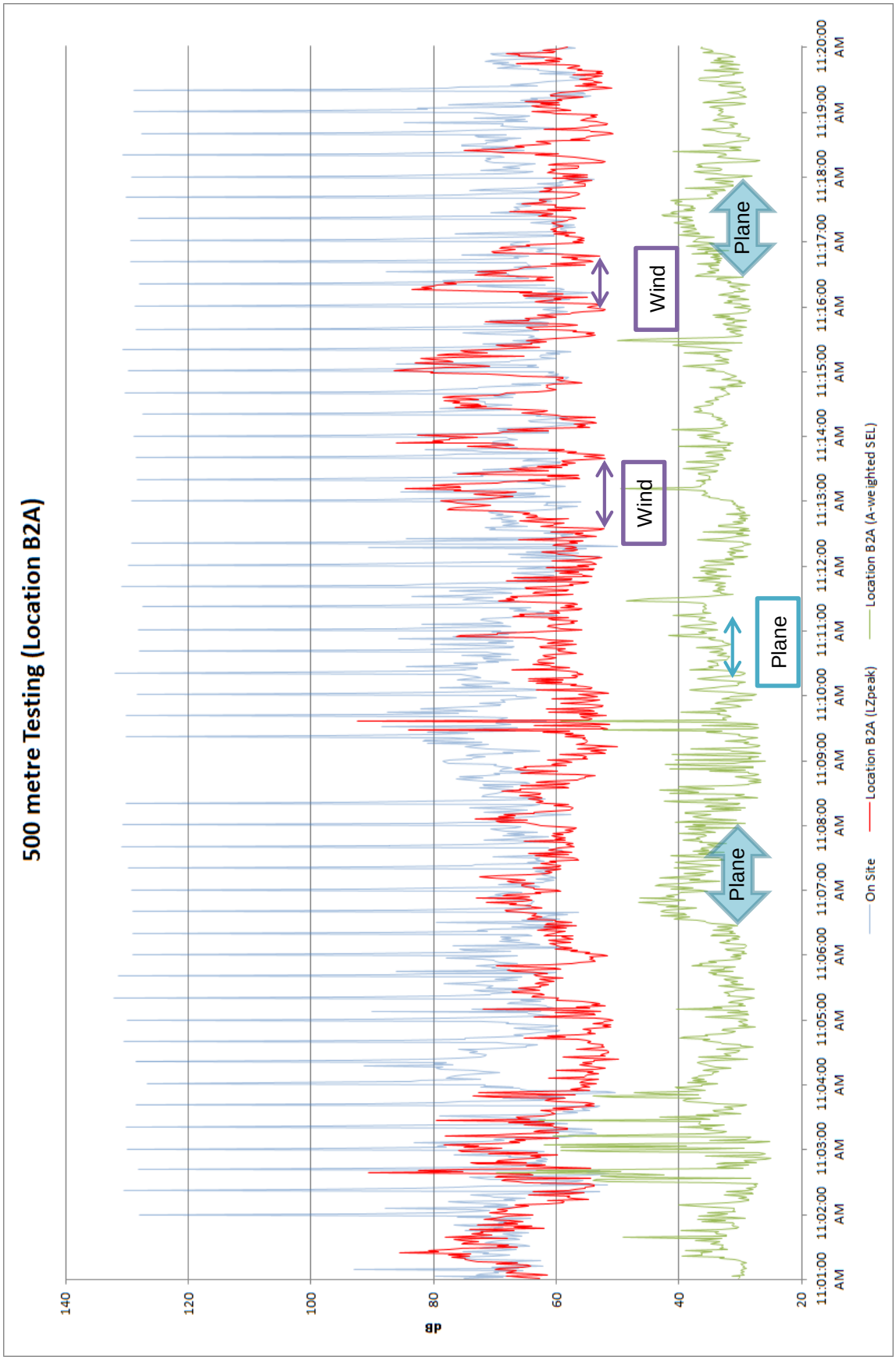
Reference Time (BFP)	On Range (BFP)	A1		A4A		B2A	
		Field Observation	Data File	Field Observation	Data File	Field Observation	Data File
11:01:59 AM	128	-	-	-	65	-	X
11:02:22 AM	131	-	-	-	59	-	64
11:02:41 AM	128	NA	64	-	X	-	X (82)
11:03:00 AM	130	NA	XR (75)	66	66	X (76)	X (76)
11:03:20 AM	130	NA	XR (89)	61	61	60	X
11:03:41 AM	129	NA	XR (81)	57	57	55	55
11:04:01 AM	127	NA	69	62	62	56	56
11:04:21 AM	129	NA	XR (87)	60	60	55	56
11:04:40 AM	131	NA	XR (75)	57	57	56	55
11:04:59 AM	130	NA	XR (82)	57	X	52	X
11:05:20 AM	132	NA	XR (90)	60	60	63	64
11:05:40 AM	131	NA	71	61	61	63	64
11:06:00 AM	129	NA	XR	61	62	54	55
11:06:20 AM	129	NA	68	63	63	60	X
11:06:40 AM	129	NA	XR (72)	XR	XR (75)	XR (60)	XR (68)
11:07:00 AM	129	NA	XR	XR	XR (68)	XR (63)	XR
11:07:20 AM	130	NA	XR (83)	XR	XR (65)	XR (59)	XR (64)
11:07:40 AM	131	NA	63	62	62	57	X
11:08:00 AM	131	NA	XR (65)	61	61	63	X
11:08:20 AM	130	NA	XR (90)	67	X	63	63
11:09:22 AM	130	NA	XR (73)	64	X	55	59
11:09:41 AM	130	NA	XR (75)	68	68	56	56
11:10:01 AM	128	XR	XR (82)	63	63	56	56
11:10:20 AM	132	XR	XR (77)	64	XR (70)	XR (58)	X
11:10:41 AM	128	NA	XR (72)	XR	XR (67)	XR (59)	XR (60)
11:11:01 AM	128	NA	XR	XR	XR	XR (55)	X
11:11:22 AM	127	NA	XR (77)	60	60	-	59
11:11:41 AM	131	NA	XR	57	57	60	X
11:12:00 AM	130	NA	XR (76)	NA	58	56	57
11:12:21 AM	129	NA	XR (72)	60	55	57	58
11:13:00 AM	129	NA	XR	61	61	XW (76)	XW(79)
11:13:20 AM	128	NA	XR (86)	65	63	56	65
11:13:40 AM	129	XR	XR (71)	59	60	55	56
11:14:00 AM	129	XR	XR (69)	65	67	X (82)	X (83)
11:14:20 AM	128	67	XR (70)	66	X	65	66
11:14:40 AM	130	NA	XR (76)	60	60	60	X
11:15:00 AM	130	XR	XR (76)	X (71)	X (71)	X (84)	X (87)
11:15:20 AM	131	59	XR (75)	58	58	X (71)	X (76)
11:15:39 AM	129	59	XR	X (73)	X (73)	64	X

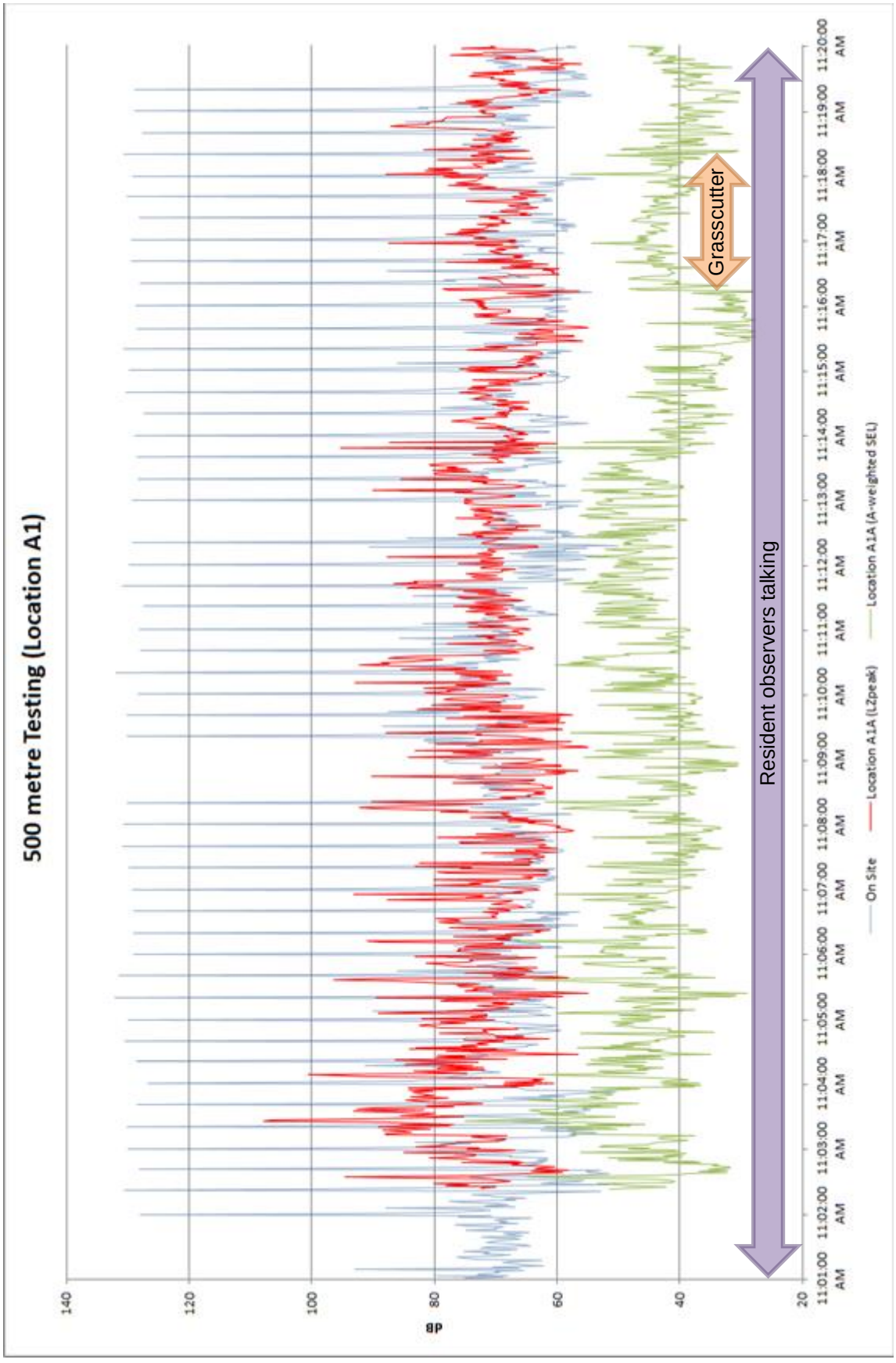
Reference Time (BFP)	On Range (BFP)	A1		A4A		B2A	
		Field Observation	Data File	Field Observation	Data File	Field Observation	Data File
11:16:00 AM	129	NA	XR (73)	59	61	55	55
11:16:21 AM	128	NA	XR	58	58	XW (76)	XW
11:16:41 AM	129	XR	XR (78)	67	X	XR (55)	XR
11:17:01 AM	129	XR	XR (74)	XR	XR (69)	54	57
11:17:21 AM	128	NA	XR (73)	XR	XR	56	X
11:17:41 AM	130	NA	XR (67)	XR	XR (62)	55	X
11:18:00 AM	129	NA	XR (79)	58	X	-	59
11:18:20 AM	131	NA	XR (73)	56	56	63	64
11:18:41 AM	128	NA	XR	55	55	51	X
11:19:00 AM	129	NA	XR (73)	60	60	64	64
11:19:20 AM	129	NA	XR (66)	54	X	51	X
Average:	**129**	**62**	**66**	**61**	**61**	**58**	**59**

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

APPENDIX D: Time Splice Graphs (500 metre range)




500 metre Testing (Location B2A)
dB
140
120
100
80
60
40
20
11:01:00 AM
11:02:00 AM
11:03:00 AM
11:04:00 AM
11:05:00 AM
11:06:00 AM
11:07:00 AM
11:08:00 AM
11:09:00 AM
11:10:00 AM
11:11:00 AM
11:12:00 AM
11:13:00 AM
11:14:00 AM
11:15:00 AM
11:16:00 AM
11:17:00 AM
11:18:00 AM
11:19:00 AM
11:20:00 AM
Wind
Wind
Plane
Plane
Plane
On Site
Location B2A (LZpeak)
Location B2A (A-weighted SEL)


500 metre Testing (Location A1)
Grasscutter
Resident observers talking
dB
140
120
100
80
60
40
20
11:01:00 AM
11:02:00 AM
11:03:00 AM
11:04:00 AM
11:05:00 AM
11:06:00 AM
11:07:00 AM
11:08:00 AM
11:09:00 AM
11:10:00 AM
11:11:00 AM
11:12:00 AM
11:13:00 AM
11:14:00 AM
11:15:00 AM
11:16:00 AM
11:17:00 AM
11:18:00 AM
11:19:00 AM
11:20:00 AM
On Site
Location A1A (LZpeak)
Location A1A (A-weighted SEL)

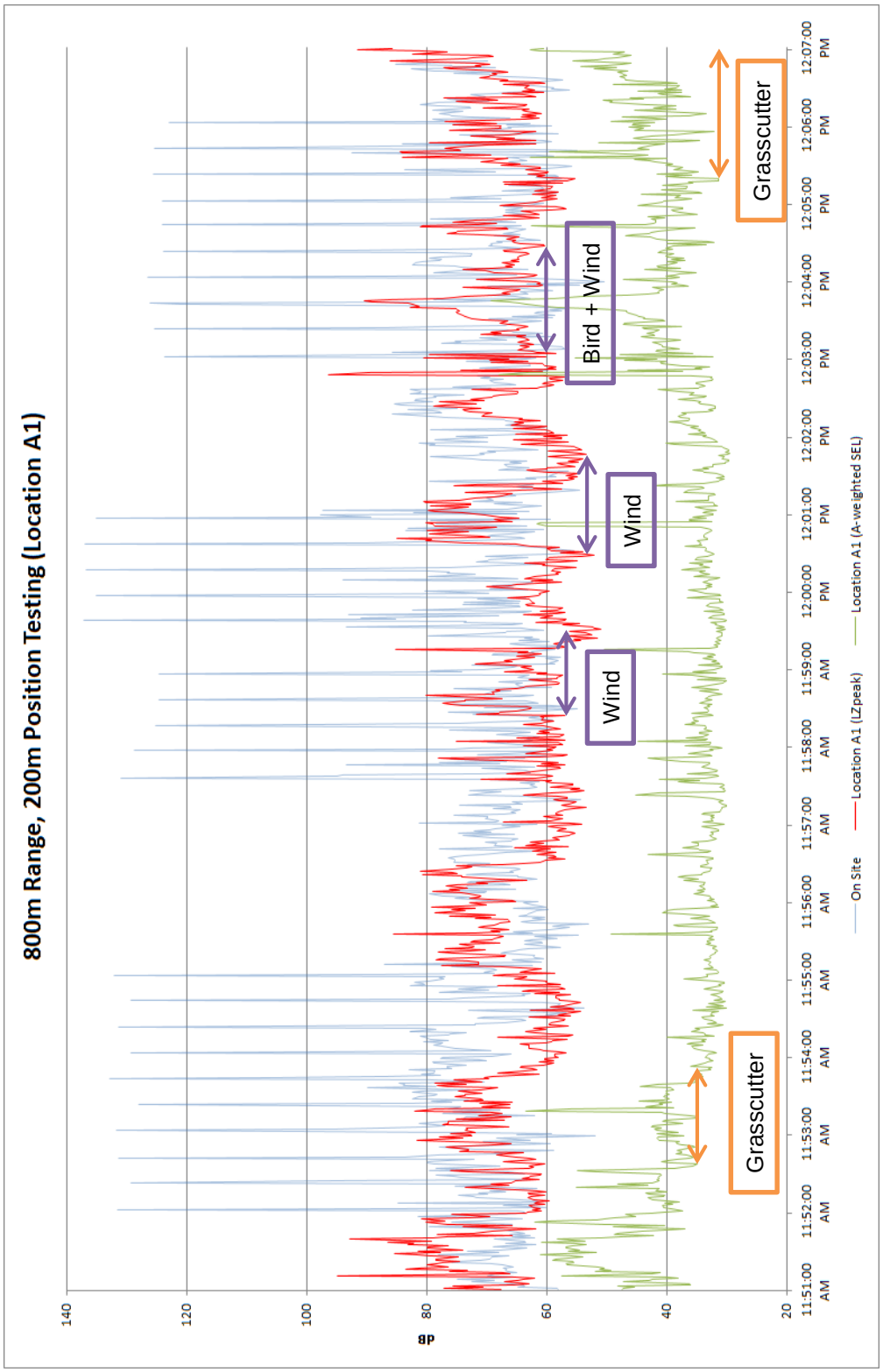
APPENDIX E: Measurement Results – for 800 metre range, 200 metre distance

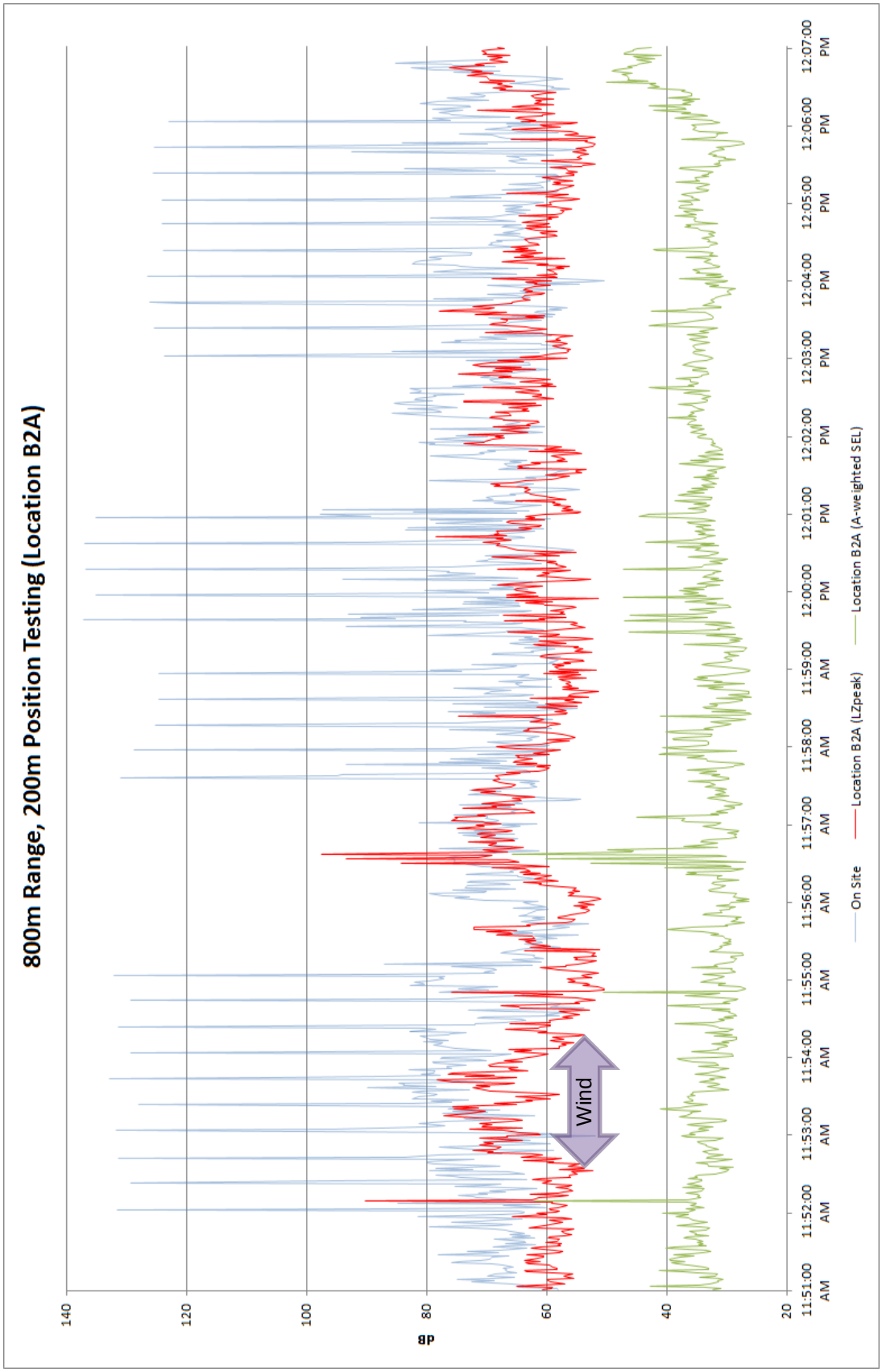
Reference Time (BFP)	On Range (BFP)	A1A		A4B		B2A	
		Field Observation	Data File	Field Observation	Data File	Field Observation	Data File
.308 Standing, Lane 1							
11:52:02 AM	132	X	62	RM	RM	59	60
11:52:23 AM	129	X (62)	69	RM	RM	58	61
11:52:42 AM	131	67	X	RM	RM	54	64
11:53:03 AM	132	X (74)	X (74)	RM	RM	XW (68)	XW (73)
11:53:23 AM	128	71	71	RM	RM	XW (78)	XW (76)
Average:	**130**	**69**	**67**	RM	RM	**57**	**62**
.308 Kneeling/Sitting at a Bench, Lane 1							
11:53:43 AM	133	68	XR (75)	RM	RM	62	XW (78)
11:54:03 AM	129	59	X	RM	RM	69	65
11:54:23 AM	131	60	62	RM	RM	58	X
11:54:44 AM	129	56	X	RM	RM	X (87)	X
11:55:03 AM	132	65	69	RM	RM	56	54
Average:	**131**	**62**	**66**	RM	RM	**61**	**60**
.308 Standing, Lane 4							
11:57:36 AM	131	60	71	61	61	69	69
11:57:57 AM	129	57	60	62	62	65	X
11:58:16 AM	125	58	64	59	X	55	X
11:58:36 AM	125	XW (76)	XW	59	X	58	63
11:58:56 AM	125	58	62	57	X	65	61
Average:	**127**	**58**	**64**	**60**	**62**	**62**	**64**
.308 Kneeling/Sitting at a Bench, Lane 4							
11:59:38 AM	137	62	X	61	61	69	67
11:59:57 AM	135	66	X	67	67	60	67
12:00:17 PM	137	58	59	69	69	55	68
12:00:37 PM	137	XW (63)	XW	67	67	60	X (70)
12:00:57 PM	135	XW (68)	XW(69)	66	66	64	63
Average:	**136**	**63**	**59**	**66**	**66**	**62**	**67**
.308 Standing, Lane 7							
12:03:02 PM	124	62	XR (81)	68	68	X (76)	68
12:03:23 PM	125	62	65	66	66	58	66
12:03:43 PM	126	X (81)	X	X (71)	X	X (71)	X
12:04:03 PM	127	XW (68)	XW	61	61	63	61
12:04:23 PM	124	60	67	64	64	62	64
Average:	**125**	**61**	**66**	**65**	**65**	**61**	**65**
.308 Kneeling/Sitting at a Bench, Lane 7							
12:04:44 PM	124	NA	X	XR (69)	XR (69)	62	64
12:05:02 PM	124	X (74)	X	XR	XR (63)	57	X

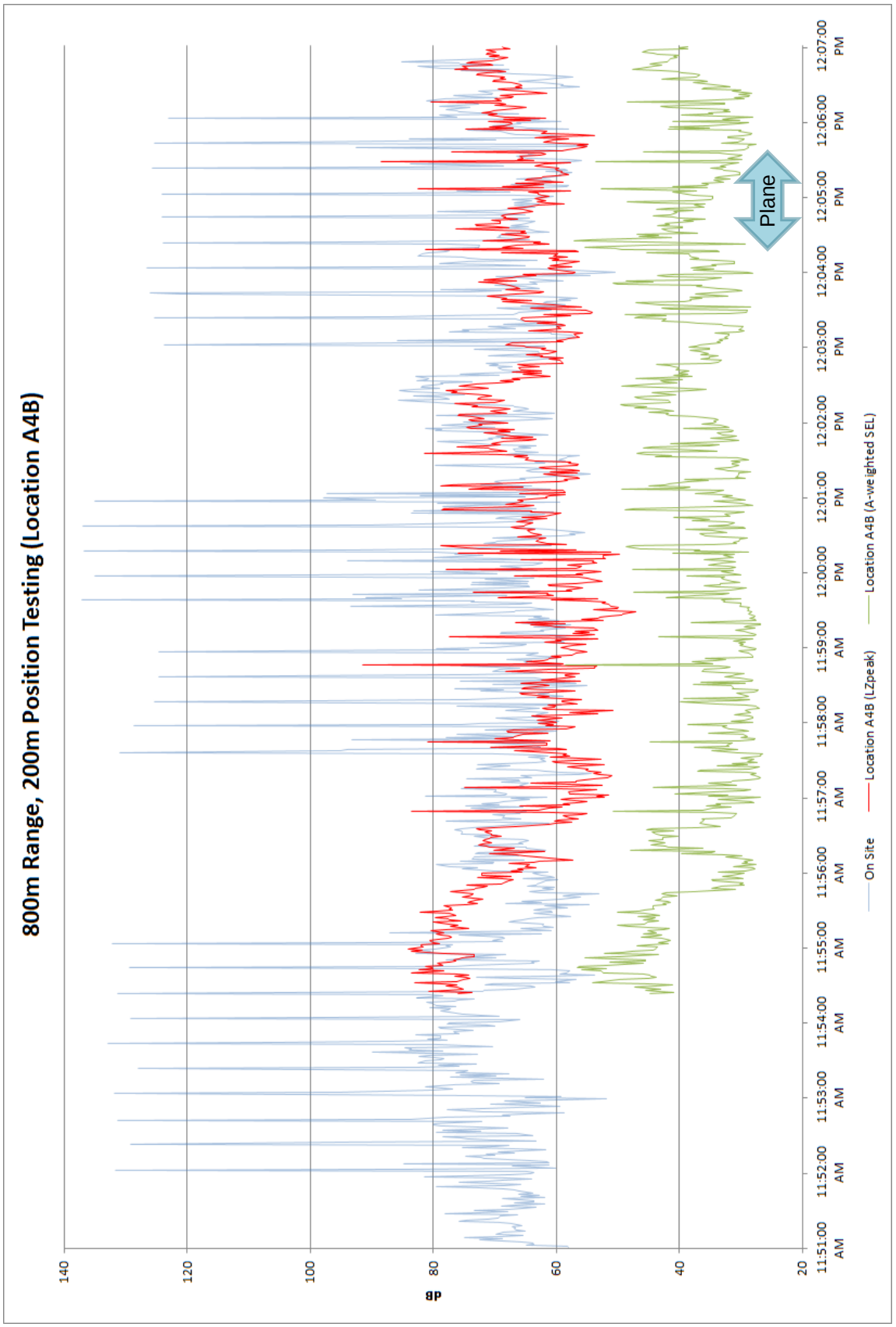
12:05:23 PM	126	X (68)	63	60	60	56	57
12:05:43 PM	125	NA	X (77)	60	62	56	55
12:06:03 PM	123	NA	X (77)	67	69	55	64
Average:	**124**	**X (71)**	**63**	**62**	**64**	**57**	**60**

X	=	Audible but not measureable in ambient (background noise level or birds)
XW	=	Audible but not measureable due to wind at time of shot
XR	=	Not measureable due to extraneous noise from resident's observer, vehicle or plane
( )	=	Extraneous peak level
-	=	No measurement
NA	=	Not audible
RM	=	Relocating Meter

APPENDIX F: Time Splice Graphs (800 m Range, 200 m Firing Distance)




800m Range, 200m Position Testing (Location B2A)
dB
140
120
100
80
60
40
20
11:51:00 AM
11:52:00 AM
11:53:00 AM
11:54:00 AM
11:55:00 AM
11:56:00 AM
11:57:00 AM
11:58:00 AM
11:59:00 AM
12:00:00 PM
12:01:00 PM
12:02:00 PM
12:03:00 PM
12:04:00 PM
12:05:00 PM
12:06:00 PM
12:07:00 PM
Wind
On Site
Location B2A (LZpeak)
Location B2A (A-weighted SEL)

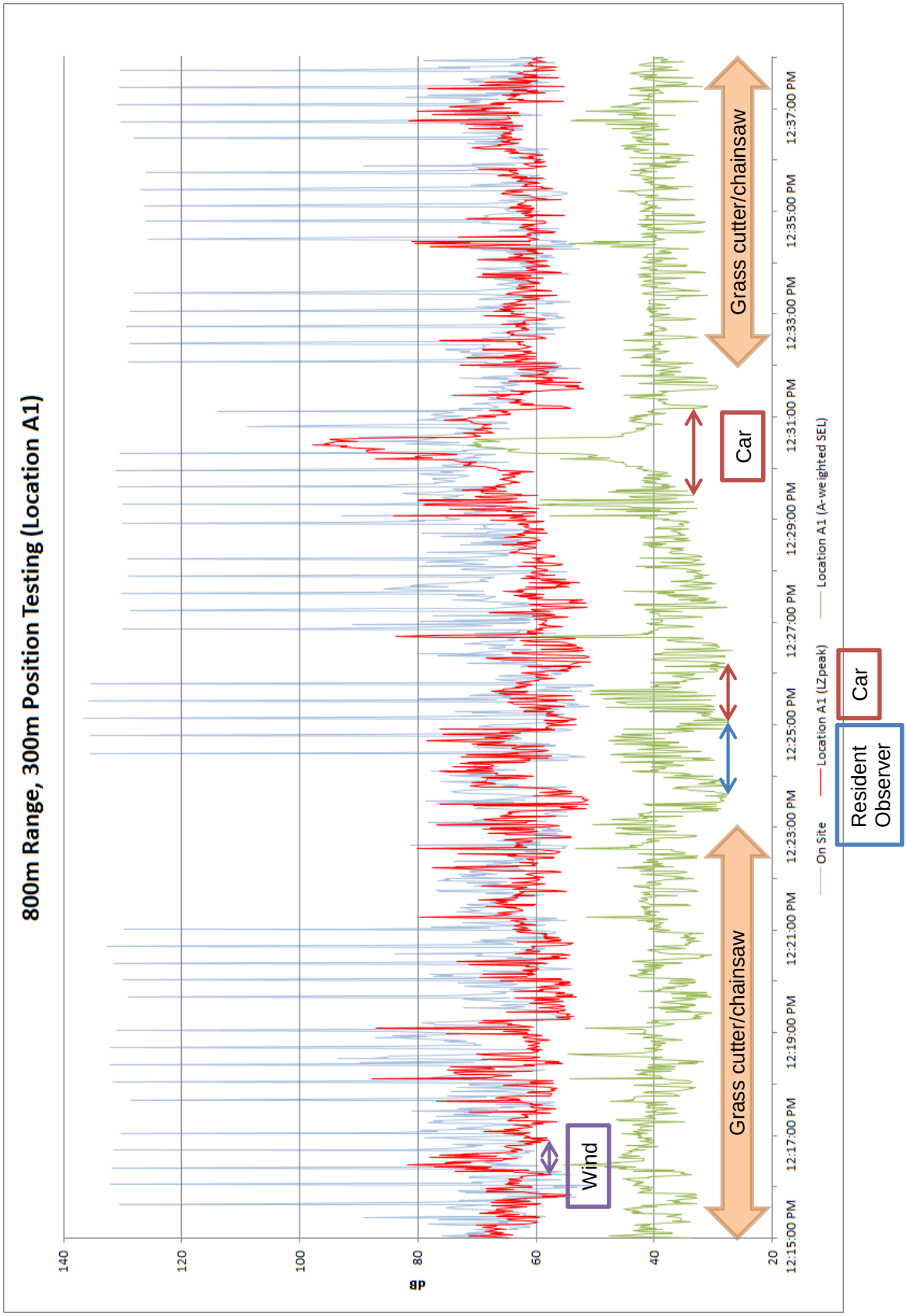

800m Range, 200m Position Testing (Location A4B)
dB
140
120
100
80
60
40
20
11:51:00 AM
11:52:00 AM
11:53:00 AM
11:54:00 AM
11:55:00 AM
11:56:00 AM
11:57:00 AM
11:58:00 AM
11:59:00 AM
12:00:00 PM
12:01:00 PM
12:02:00 PM
12:03:00 PM
12:04:00 PM
12:05:00 PM
12:06:00 PM
12:07:00 PM
Plane
On Site
Location A4B (LZpeak)
Location A4B (A-weighted SEL)

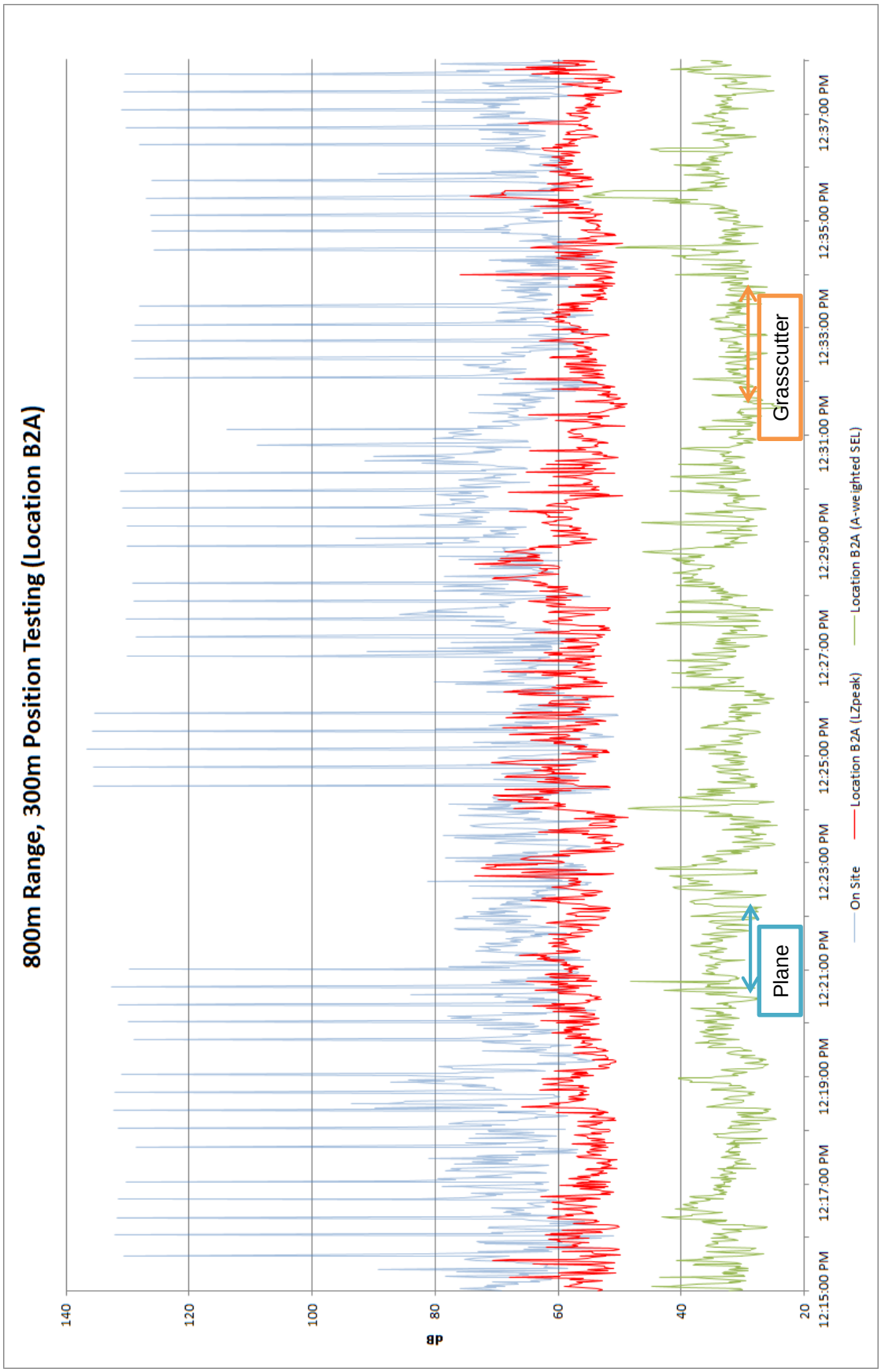
APPENDIX G: Measurement Results – for 800 metre range, 300 metre distance

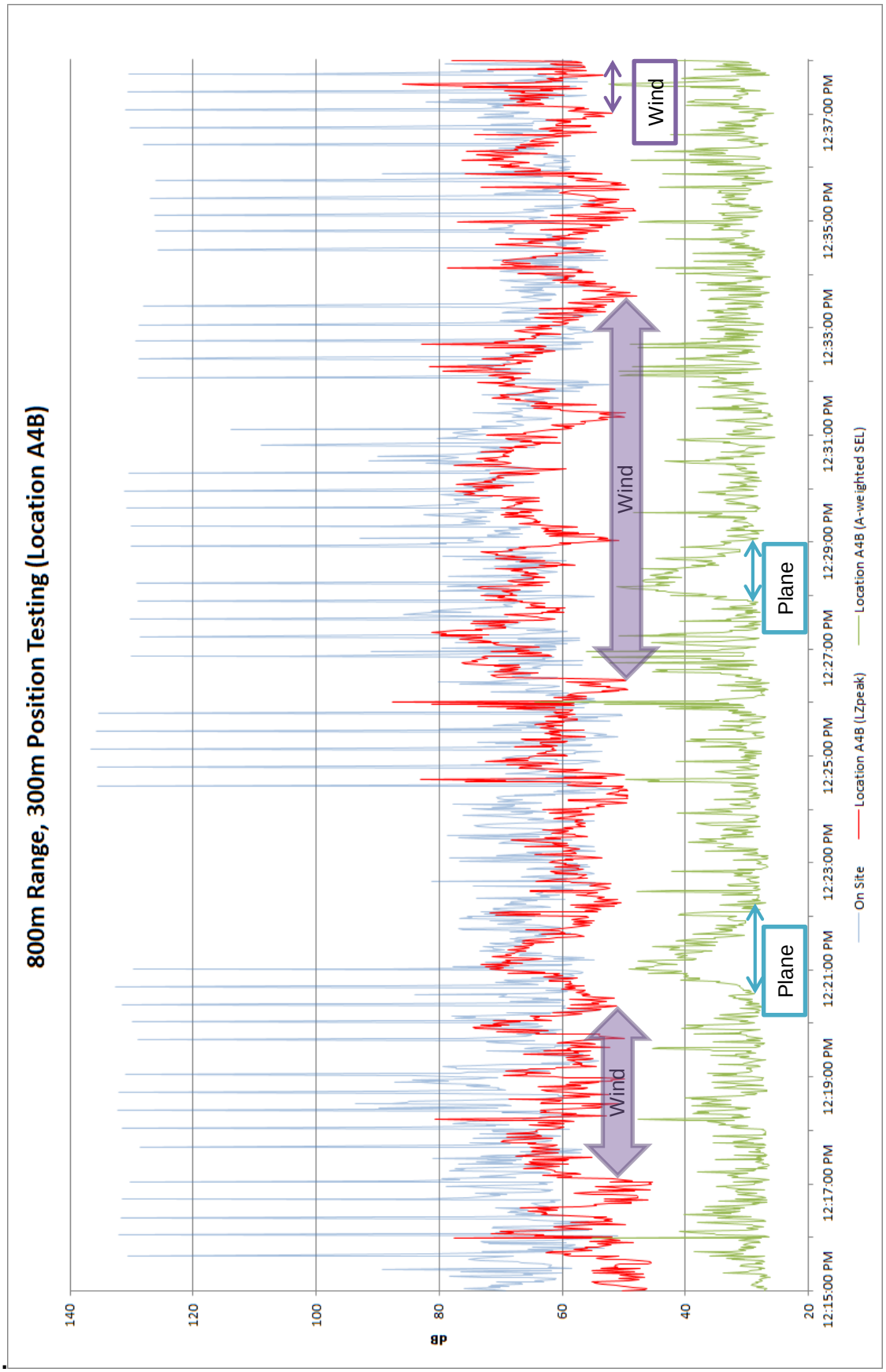
Reference Time (BFP)	On Range (BFP)	A1A		A4B		B2A	
		Field Observation	Data File	Field Observation	Data File	Field Observation	Data File
.308 Standing, Lane 1							
12:15:39 PM	131	61	68	60	60	54	56
12:16:02 PM	132	61	65	65	65	56	62
12:16:21 PM	132	XW (74)	XW (77)	55	55	52	62
12:16:42 PM	132	X (72)	X (65)	53	53	56	60
12:17:02 PM	130	62	66	52	52	55	X
Average:	**131**	**61**	**66**	**57**	**57**	**55**	**60**
.308 Kneeling/Sitting at a Bench, Lane 1							
12:17:41 PM	129	XR	65	65	65	54	55
12:18:02 PM	132	66	61	62	X	57	X
12:18:22 PM	132	XR (75)	XR (62)	64	64	54	54
12:18:42 PM	132	X (61)	X (62)	59	X	55	57
12:19:02 PM	131	XR (61)	XR (66)	XW (70)	XW(70)	59	58
Average:	**131**	**66**	**63**	**63**	**65**	**56**	**56**
.308 Prone, Lane 1							
12:19:41 PM	129	59	64	55	X	55	56
12:20:01 PM	130	56	66	XW (71)	XW(71)	59	63
12:20:20 PM	132	62	X (72)	59	59	60	64
12:20:40 PM	133	61	61	XR (60)	XR (60)	49	60
12:21:00 PM	130	XR	64	XR	XR (72)	XR (61)	XR (59)
Average:	**131**	**60**	**64**	**57**	**59**	**56**	**61**
.308 Standing, Lane 4							
12:24:26 PM	136	63	66	58	59	63	X
12:24:47 PM	136	XR (68)	XR (76)	67	X	62	63
12:25:07 PM	137	59	X	62	62	54	57
12:25:27 PM	136	XR	65	62	62	62	X
12:25:47 PM	135	64	X	61	61	52	67
Average:	**136**	**62**	**66**	**62**	**61**	**59**	**62**
.308 Kneeling/Sitting at a Bench, Lane 4							
12:26:51 PM	130	NA	60	-	XW(73)	54	55
12:27:13 PM	129	NA	61	XW (73)	XW(80)	56	X
12:27:33 PM	130	60	X	63	X	56	X
12:27:53 PM	129	63	62	XR (67)	XR (73)	64	65
12:28:13 PM	129	60	61	XR	XR (67)	68	64
Average:	**129**	**61**	**61**	**63**	**-**	**60**	**61**
.308 Prone, Lane 4							
12:28:55 PM	130	XR	63	XR	XR (67)	58	63
12:29:17 PM	130	60	XR (79)	58	X	61	X
12:29:38 PM	131	XR (67)	69	66	XW(70)	NA	X
12:29:57 PM	131	XR	X	XW (77)	XW(77)	58	58

Reference Time (BFP)	On Range (BFP)	A1A		A4B		B2A	
		Field Observation	Data File	Field Observation	Data File	Field Observation	Data File
12:30:17 PM	130	XR	X	64	XW(72)	55	65
Average:	**130**	**60**	**66**	**63**	-	**58**	**62**
.308 Standing, Lane 7							
12:32:04	129	62	66	XW (67)	XW(70)	54	X
12:32:25	129	62	63	XW (68)	XW(73)	XR (52)	XR (62)
12:32:45	129	NA (62)	64	XW (69)	XW(71)	54	63
12:33:03	129	NA (64)	67	64	64	57	X
12:33:24	128	NA (60)	65	55	55	61	60
Average:	**129**	**62**	**65**	**60**	**60**	**57**	**62**
.308 Kneeling/Sitting at a Bench, Lane 7							
12:34:27	126	NA	61	56	60	59	X
12:34:48	126	NA	63	58	58	56	56
12:35:06	126	NA	64	NA	62	55	54
12:35:25	127	NA	65	54	X	61	X
12:35:45	126	NA	X	54	58	60	56
Average:	**126**	NA	**63**	**56**	**60**	**58**	**55**
.308 Prone, Lane 7							
12:36:25	128	NA	67	61	67	60	60
12:36:44	130	NA	X (82)	64	64	59	X
12:37:04	131	NA	X	59	59	56	57
12:37:24	131	NA	X (78)	XW (67)	XW(70)	55	X
12:37:44	131	NA	60	53	64	53	64
Average:	**130**	NA	**64**	**59**	**64**	**57**	**60**

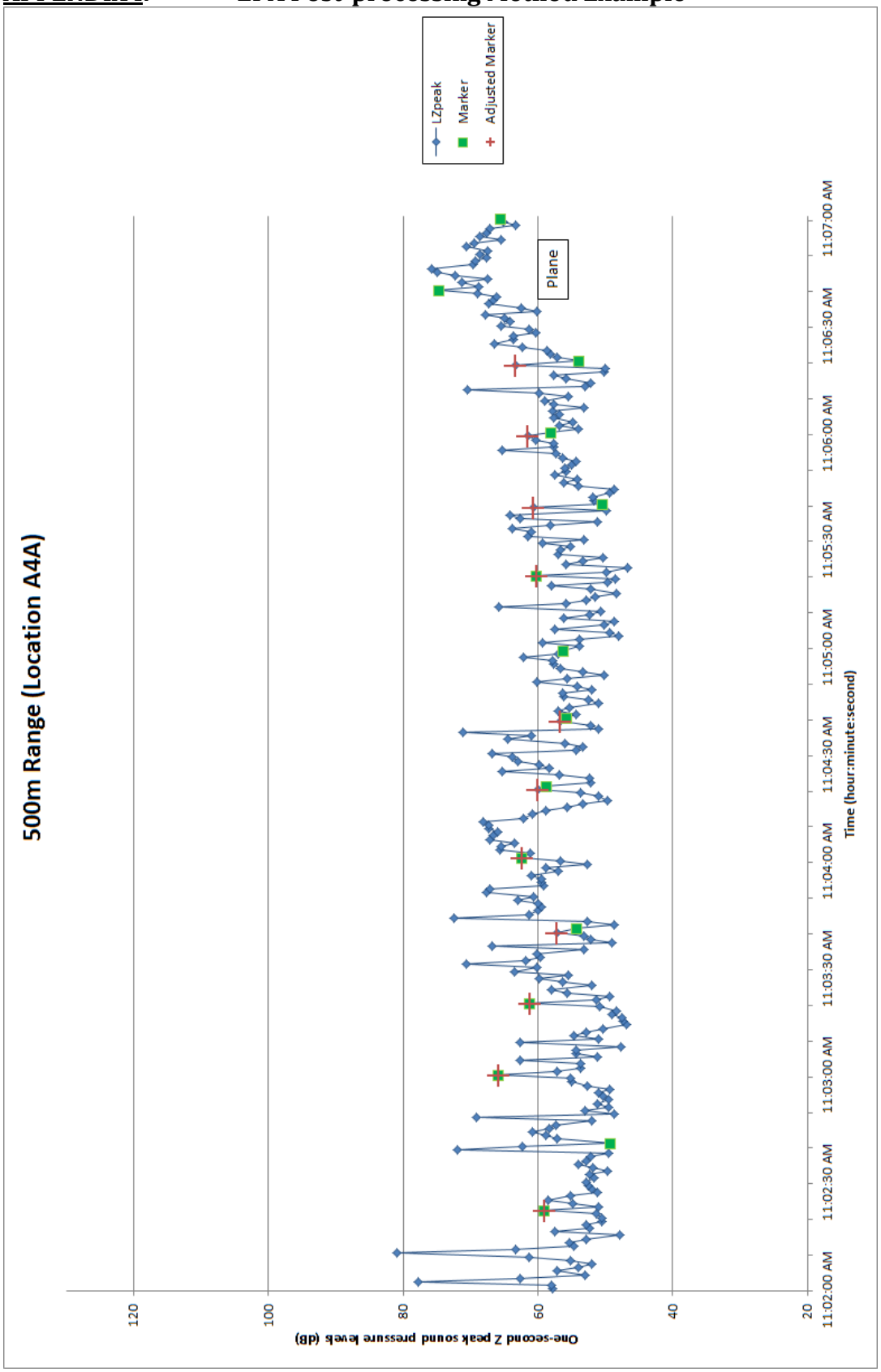
APPENDIX H: Time Splice Graphs (800 m Range, 300 m Firing Distance)



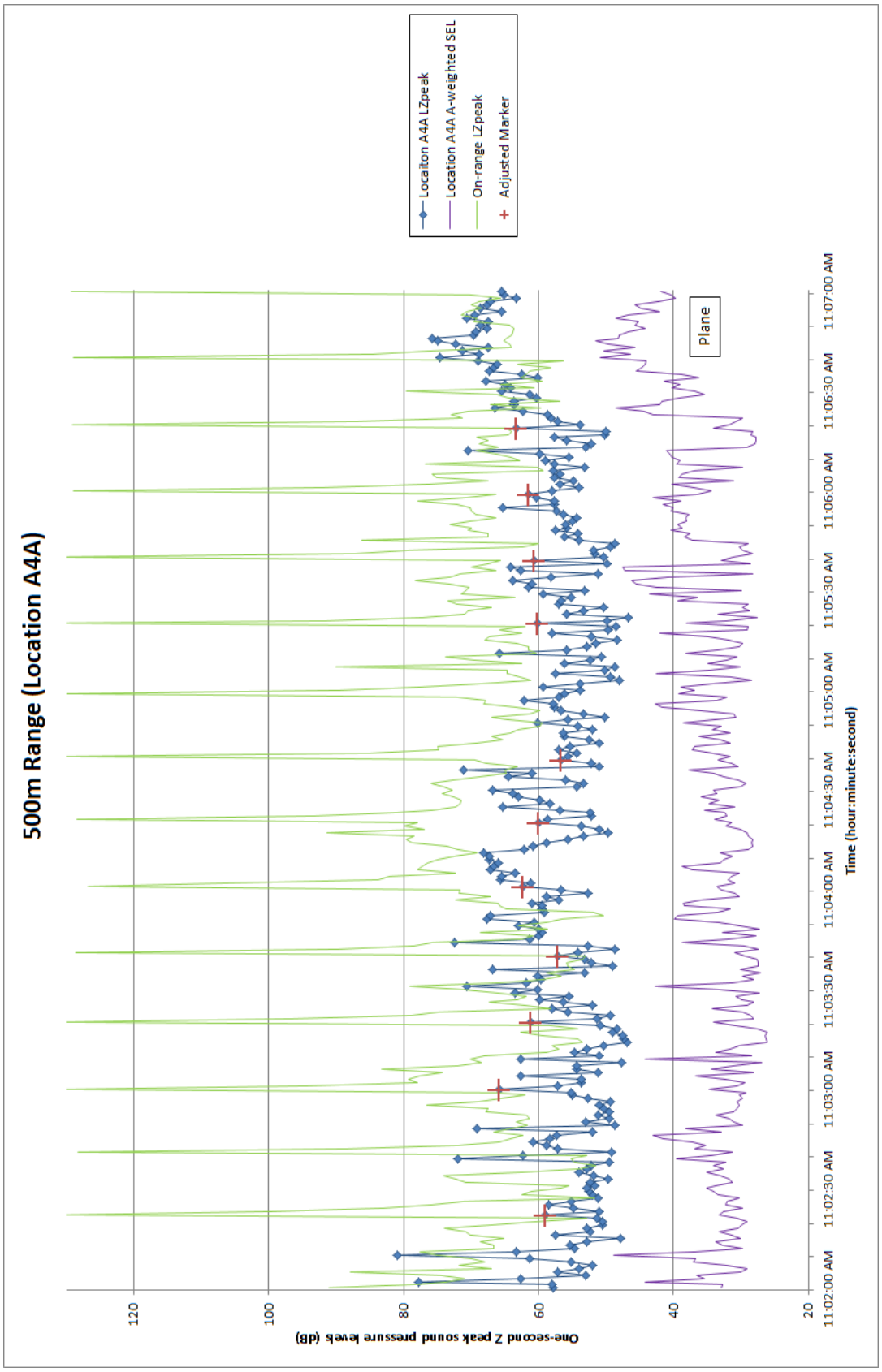

800m Range, 300m Position Testing (Location B2A)
dB
140
120
100
80
60
40
20
12:15:00 PM
12:17:00 PM
12:19:00 PM
12:21:00 PM
12:23:00 PM
12:25:00 PM
12:27:00 PM
12:29:00 PM
12:31:00 PM
12:33:00 PM
12:35:00 PM
12:37:00 PM
Grasscutter
Plane
On Site
Location B2A (LZpeak)
Location B2A (A-weighted SEL)


800m Range, 300m Position Testing (Location A4B)
dB
140
120
100
80
60
40
20
12:15:00 PM
12:17:00 PM
12:19:00 PM
12:21:00 PM
12:23:00 PM
12:25:00 PM
12:27:00 PM
12:29:00 PM
12:31:00 PM
12:33:00 PM
12:35:00 PM
12:37:00 PM
Wind
Wind
Plane
Plane
Wind
On Site
Location A4B (LZpeak)
Location A4B (A-weighted SEL)

APPENDIX I: EPA Post-processing Method Example



Measurement	Pre-shot LZpeak	Shot LZpeak	Shot/pre-shot difference	Shot category
1	58.1	65.4	7.3	A
2	51.3	58.9	7.6	A
3	62.4	49.1	-13.3	Not valid
4	55.1	65.8	10.7	A
5	50.9	61.2	10.3	A
6	53.3	57.3	4.0	B
7	56.6	62.4	5.8	A
8	53.8	60.0	6.2	A
9	52.3	56.7	4.4	B
10	57.0	56.2	-0.8	Not valid
11	48.6	60.1	11.5	A
12	49.8	60.7	10.9	A
13	60.3	61.5	1.2	B
14	50.0	63.3	13.3	A
15	69.1	74.7	5.6	Not Valid (plane)
16	65.5	67.5	2.0	Not Valid (plane)
17	63.0	64.8	1.8	Not Valid (plane)
18	59.8	61.7	1.9	B
19	57.8	61.0	3.2	B
20	66.6	65.6	-1.0	Not valid
21	63.5	62.8	-0.7	Not valid
22	64.4	68.0	3.6	B
23	61.8	63.3	1.5	B
24	64.8	70.1	5.3	Not valid (plane)
25	65.4	66.5	1.1	Not valid (plane)
26	63.7	62.6	-1.1	Not valid (plane)
27	56.6	60.2	3.6	B
28	54.8	56.7	1.9	B
29	52.9	58.2	5.3	A
30	52.8	54.5	1.7	B
31	58.5	61.2	2.7	B
32	57.9	62.9	5.0	A
33	60.1	60.2	0.1	B
34	64.5	66.9	2.4	B
35	64.0	63.2	-0.8	Not valid
36	58.8	59.9	1.1	B
37	70.2	71.2	1.0	Not valid (extraneous noise)
38	56.5	57.8	1.3	B
39	62.3	72.9	10.6	Not valid (extraneous noise)
40	58.4	61.3	2.9	B
41	56.5	58.0	1.5	B
42	66.6	62.9	-3.7	Not valid (plane)
43	68.2	69.0	0.8	Not valid (plane)
44	68.9	68.1	-0.8	Not valid (plane)
45	61.9	62.1	0.2	Not valid (plane)
46	57.4	57.0	-0.4	Not valid (plane)
47	53.2	56.2	3.0	B
48	50.6	54.8	4.2	B
49	52.6	59.6	7.0	A
50	54.2	54.2	0.0	Not valid
Number of category A shots				**12**
Number of category B shots				**19**
Final noise level (arithmetic average of category A and B shots)				**61**


500m Range (Location A4A)
Locaiton A4A LZpeak
Location A4A A-weighted SEL
On-range LZpeak
Adjusted Marker
Plane
One-second Z peak sound pressure levels (dB)
120
100
80
60
40
20
11:02:00 AM
11:02:30 AM
11:03:00 AM
11:03:30 AM
11:04:00 AM
11:04:30 AM
11:05:00 AM
11:05:30 AM
11:06:00 AM
11:06:30 AM
11:07:00 AM
Time (hour:minute:second)