UPDATE REPORT TO DISTRICT PLAN COMMITTEE

DATE: **19 February 2020**

CHAPTER SECTION TITLE: **Noise**

SECTION TITLE/TOPIC: **Update on Progress of the NZDF West Melton Rifle Range Workstream**

PHASE: **Draft Provisions & Section 32 Evaluation**

TOPIC LEAD: **Ben Rhodes**

PREPARED BY: **Vicki Barker**

EXECUTIVE SUMMARY

Summary of post-engagement Preferred Option(s) endorsed by DPC	*To proceed with the development of specific provisions that will require acoustic attenuation in relation to noise sensitive development within an identified noise contour subject to further noise information and development.*
Baseline Report link	*Baseline Report*
Preferred Option Report link	*Preferred Option Report*
Post Engagement Report link	*Post Engagement Report*
Recommendation/Next Steps	*The Committee notes that:* *i. an updated noise report has been received from NZDF and is currently subject to peer review which is yet to be completed. The extent of the proposed outer noise contour has increased, and the noise contour levels and extent of the outer noise contour may change further subject to peer review; and* *ii. direct communications with select land owners will be initiated to provide an update about the revised noise report being available on the Council's website and next steps; and* *iii. the timing of the written communications to all affected landowners will follow the completion of the peer review and the extent of the noise contours being confirmed by Council, assuming this information is available by mid-March ahead of notification of the Proposed Plan. If not*

	available by mid-March, communications will be sent advising of the delay and that participation will need to occur via the submission process following notification.

1.0 Introduction

The New Zealand Defence Force (NZDF) originally sought a no-complaints covenant approach to protect the West Melton Rifle Range (WMRR) from reverse sensitivity effects. This approach would have required any future subdivision or new land use development for a noise sensitive activity within the proposed 55 Ldn noise contour to have a covenant registered on the title of the property waiving rights of complaint about the Range in relation to noise and vibration. If a covenant was not entered into, a resource consent would be required.

Affected land owners whose property was within the 55 Ldn noise contour were consulted about this approach in May 2019 and the approach was overwhelmingly opposed. A summary of the land owner feedback is detailed in the post-engagement report to DPC.

Due to the strong landowner opposition to no-complaints covenants, the District Plan Committee (DPC) decided at its meeting on 26 June 2019 that an alternative option of acoustic attenuation be progressed to the 'Drafting and Section 32 Evaluation Phase'. This option seeks to avoid new noise sensitive activities establishing within a 65 Ldn noise contour around the WMRR, and to require acoustic attenuation for new noise sensitive developments between the 55 and 65 Ldn contours[1].

It is also of note that the approach of requiring acoustic attenuation within an identified noise contour is one that Council is pursuing in association with other strategic infrastructure (e.g. Inland Ports and Christchurch International Airport) and therefore the proposed approach for the WMRR will achieve consistency across the Proposed Plan.

At the time of land owner consultation last year, the noise contours provided by NZDF were based on a NZDF commissioned Malcolm Hunt Associates Ltd (MHA) noise study and modelling dated 2013. NZDF noted that the contours were preliminary and they intended to provide a revised noise report and contours. An updated noise report and noise contour map prepared by Tonkin & Taylor (T&T), 'West Melton Rifle Range - Assessment of Noise', dated 18 December 2019 was received by Council on 14 January 2020.

The purpose of this report is to update DPC regarding:

- The T&T noise report - key findings and changes;
- The Council expert peer review of the T&T noise report;
- Land owner communications;
- Draft provisions.

[1] The 55 Ldn contour generally represents a threshold of annoyance above which land use planning restrictions are considered warranted. The 65 Ldn contour is a threshold beyond which is generally found to be unacceptable for residential and other sensitive land uses.

1.0 Tonkin & Taylor Noise Report

The T&T noise report is attached as **Appendix 1**.

The report addresses the four main sources of noise at the WMRR:

- Weapons firing on the Wooster A & B Ranges;
- Grenade training on the Grenade Range;
- 40 mm mortar firing;
- Controlled detonations of high explosives less than 680 grams.

The location of the Ranges and firing points are shown on Figure 4.1 in the report. The report states that night time use of the Ranges takes place approximately 20 times per year, mainly on the Wooster Ranges and very few grenades are used at night. The noise assessment also includes allowance for the use of the Barrett sniper rifle which has recently been procured by NZDF and is used on the Wooster B Range.

A computer noise model of the WMRR and wider area was constructed by T&T incorporating factors such as terrain data, buildings and shielding, ground absorption, wind, and source sound levels. Based on the modelling, 55 and 65 dB noise contours have been produced and justification provided for these levels. The model was then validated using measured data recorded by MHA and additional data collected by T&T in August 2019.

The findings of the T&T report are that the noise contour is comparable in size and shape to the MHA report, but that the new weapon type has resulted in an extension of the 55 dB contour to the south of the Range in the vicinity of Halkett and Weedons Ross Roads. The report states that the new contours should replace the preliminary contours provided to Council based on the MHA report.

A map comparing the former 55 and proposed 55 dB noise contour has been prepared by Council's GIS Team and is attached as **Appendix 2**. This map shows that 33 additional properties are affected as a result of the proposed extended 55 dB noise contour, which means that there are potentially newly affected land owners that are not yet aware of proposed provisions potentially affecting their property. However, as the extent of the contour is currently subject to peer review and may change, the extent of land owners affected has not yet been confirmed as discussed further below.

2.0 Council Peer Review of Tonkin & Taylor Noise Report

The T&T report was provided to Council's Acoustic Consultants, Acoustic Engineering Services (AES) on 16 January 2020 for peer review. AES were also provided with the earlier MHA report for reference, and the preliminary 55 dB noise control boundary map provided by NZDF last year that formed the basis of land owner consultation.

The peer review focuses on the extent of the noise contours and the justification for them. At the time of writing this report the peer review is not complete as AES have sought further information from T&T. The key further information sought by AES includes:

- The relative sound levels generated by each noise source assumed in the modelling;
- How the directivity of each noise source, which is a characteristic of weapon noise, has been accounted for in the modelling;
- What level of activity currently occurs on the WMRR and how this relates to the future predicted scenario and at what time in the future the predicted level of activity is anticipated to occur;
- The seasonal distribution of each activity over a typical year as the report implies there will be busier and quieter periods;
- The number of events included in the model during the night-time period, and whether 40 mm mortars or detonations of high explosives will occur at night;
- Greater justification for the proposed 55/65 Ldn thresholds for this type of noise due to the impulsive nature of the noise and the increased perception of low frequency sound at a distance.

Overall, preliminary indications from AES are that an 'outer noise control boundary' inside which noise sensitive development is required to include acoustic insulation measures and an 'inner noise control boundary' inside which new dwellings are avoided is a reasonable approach to managing noise in relation to the WMRR. However, it is not yet clear at which Ldn (annual average) noise levels these boundaries should be set, and further information is necessary to establish this and the resultant extent of the noise contours.

Furthermore, a key practical issue is where a contour line only slightly traverses a property boundary, how it is treated. T&T have also been asked to comment in this respect. AES have commented that they would not be particularly concerned about the marginal sites unless they hold dwellings within the extent of the contour, or dwellings could realistically be constructed at some point in the future.

In summary, the contours have not yet been confirmed and there could be more or fewer properties potentially affected once the peer review is completed. It is anticipated by AES that further amendments to the T&T noise report and noise contours will be required.

3.0 Landowner communications

3.1 Previous landowner communications

A letter was posted to landowners on 7 May 2019 to provide an overview of the proposed former no-complaints covenant option, the reasons why it was proposed, answers to common questions, and to seek an understanding of what alternative options were supported by landowners if the preferred option wasn't supported. Approximately 200 letters were sent and approximately 80 individual responses were received, with almost all in opposition.

Following this extensive opposition, a further letter was posted and/or emailed on 18 June 2019 explaining that DPC was to make a decision at its meeting of 26 June 2019 on how the Rifle Range should be managed in the Proposed District Plan. The acoustic attenuation option was proposed and endorsed by DPC in June 2019.

A further letter was sent to landowners on 7 August 2019 to advise of the proposed approach of acoustic attenuation and advising that an updated noise report is to be commissioned by NZDF to confirm the extent of the noise contours. The letter also advised that Council's acoustic consultants would peer

review the updated NZDF report, and that both the noise report and Council's peer review would be made available to the public on the Council's website, expected by the end of 2019. The letter also noted that NZDF still planned to pursue the no-complaints covenant approach via the District Plan Review process through a NZDF submission on the Proposed Plan.

3.2 Future landowner communications

As the peer review is not yet complete, we will email select land owners who have been more involved in this process to date and who have strong ties with the local community. We will advise them of the NZDF noise information received, the current peer review and the DPC report which they can access along with the T&T noise report and noise contour map at Appendix 1 in the DPC public agenda on the Council website (www.selwyn.govt.nz/dpcagendas). The email will be sent after the DPC meeting.

A mail-out to all potentially affected landowners is not considered beneficial at this point given the T&T noise report and noise contours could still be subject to change following Council's peer review and the exact affected landowners have not yet been confirmed.

If the peer review is completed and the noise contours are confirmed by mid-March, which provides sufficient time ahead of public notification in May 2020, written communications with all affected landowners is proposed. It is proposed to post and/or email a letter to all affected landowners advising that the final noise report, noise contour map and the Council peer review of the noise report are available on the Selwyn District Council website. This approach of referring to the information on the website is considered more efficient than including this information with every letter and/or email.

It is proposed to prepare two letters - one for the original landowners identified as affected, and one to any newly affected landowners as a result of any confirmed extension to the outer noise contour. Any newly affected landowners will require additional detail to explain the background to the current proposal. The letters will also explain the proposed District Plan rules at a high level.

NZDF have also been asked to confirm whether they will still be pursuing the no-complaints covenant approach by way of submission once the Proposed District Plan is notified or whether they now support the acoustic attenuation approach. If they now support acoustic attenuation this can also be communicated to landowners.

As public notification of the District Plan is currently scheduled for May 2020, there is no time to consider any additional landowner feedback, and therefore the letters will be clear that they are being sent for information purposes only and that any feedback will need to be via the public submission process once the Proposed District Plan is notified.

If the peer review and noise contours are not finalised by mid-March prior to public notification, emails/letters will instead be sent advising of this delay and that participation will be required through the formal submission and further submission process once the Proposed Plan is notified. In this scenario, Council will also use the previous MHA based noise contours that have been consulted on with land owners, and not the new contours submitted by NZDF with the T&T report. The extent of the contours would then need to be determined through the submissions, further submissions and hearings process.

4.0 Draft provisions

A draft set of provisions have been prepared based on avoiding development within an 'inner noise contour' and requiring acoustic attenuation for new development within an 'outer noise contour'. The provisions will sit within the Noise Chapter.

Even though the contour levels and their mapped extent is still subject to peer review, the rules can continue to be developed and finalised once the contour levels are agreed. The mapping will affect the extent of the application of the rules only (and land owner communications).

Aside from the District Plan rules, placing notes on titles[2] or LIMS as a further measure to advise of the provisions that apply is also being considered.

5.0 Recommendations/Next Steps

The Committee notes that:

i. an updated noise report has been received from NZDF and is currently subject to peer review which is yet to be completed. The extent of the proposed outer noise contour has increased, and the noise contour levels and extent of the outer noise contour may change further subject to peer review; and

ii. direct communications with select land owners will be initiated to provide an update about the revised noise report being available on the Council's website and next steps; and

iii. the timing of the written communications to all affected landowners will follow the completion of the peer review and the extent of the noise contours being confirmed by Council, assuming this information is available by mid-March ahead of notification of the Proposed Plan. If not available by mid-March, communications will be sent advising of the delay and that participation will need to occur via the submission process following notification.

[2] This will be difficult to do other than through a subdivision process creating new titles. To put a covenant on existing titles, which may be sold without a LIM, would have to be volunteered by the existing land owner. Outside a subdivision process Selwyn District Council's powers, with regards to advisory notes, may be limited to LIMs.

Appendix 1 – T & T Noise Report

REPORT

Tonkin+Taylor

West Melton Rifle Range - Assessment of Noise

Prepared for
New Zealand Defence Force
Prepared by
Tonkin & Taylor Ltd
Date
December 2019
Job Number
1010541

Exceptional thinking together
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Document Control

Title: West Melton Rifle Range - Assessment of Noise					
Date	**Version**	**Description**	**Prepared by:**	**Reviewed by:**	**Authorised by:**
31 Oct 19	1	Draft for client review	D Humpheson	M Bevington	P Kneebone
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Distribution:

New Zealand Defence Force	1 PDF copies
Tonkin & Taylor Ltd (FILE)	1 electronic copy

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1 Introduction

The New Zealand Defence Force (NZDF) has operated a rifle range at West Melton, approximately 25 kilometres from the centre of Christchurch, since the 1940s. The West Melton Rifle Range (the Range/WMRR) is used primarily as a rifle range, but also for grenade practice and training in the use of explosives, and for general military training. It is designated in the Selwyn District Plan for Defence Purposes – Military Training Area and is a nationally important training facility for NZDF.

Military training activities can create impulsive low frequency acoustic events which propagate over long distances. These events can cause disturbance to members of the public through perceived effects such as exposure to noise and vibration and rattling of windows (and other fixtures).

NZDF has commissioned Tonkin & Taylor Ltd (T+T) to update the noise control boundaries[1] that it provided to Selwyn District Council (SDC). These contours were produced by Malcolm Hunt Associates (MHA). As part of this exercise the following tasks were undertaken:

- A description of the characteristics of noise from military ranges in general and from WMRR in particular (Section 2);
- An overview of applicable noise standards at WMRR;
- Review of the noise modelling assumptions that informed the MHA noise control boundaries;
- Inclusion of new noise source data to reflect current weapon types used by NZDF;
- Carry out noise monitoring data at offsite locations for validation purposes;
- Comparison of the output of the T+T SoundPLAN noise model with the previous MHA model for the site, with particular attention to the extent of the proposed 55 dB(A) Ldn outer noise control boundary and supporting justification for its use; and
- Assessment of the extent of the 65 dB(A) Ldn inner noise control boundary.

A glossary of terms is provided in Appendix A.

[1] Malcolm Hunt Associates, West Melton Training Area – Updated Noise Predictions 2010.

2 Noise from Military Training Activities

2.1 Human perception

The noise generated by military training activities, which involves the use of weapons or explosives, typically produces sound energy distributed across a broad range of acoustic frequencies. Large-calibre guns will generate higher proportions of low frequency energy compared to smaller calibre weapons. At the distances which communities are typically located from military training areas (>500 m and typically more than 1 km away), atmospheric absorption of high frequency sound (>500 Hz) will generally result in an increased perception of low frequency sound.

Environmental noise from industry and transportation is commonly expressed using the A-weighted sound pressure level. The A-weighting is used to mimic the response of the human ear to sounds of different frequencies and at normal levels of sound intensity[2]. The human ear is less sensitive to low and high frequency sounds compared to mid frequencies at which human speech is centred. As military training activity sound is commonly in the low frequency bands, particularly at larger distances, and at high intensities, the A-weighted scale can underemphasise the human response to noise from weapons and explosions (which is perceived not only through the ear, but also as secondary vibration). This is why C-weighted sound level descriptors are often used to assess weapon noise due to the greater sensitivity of the C-weighting filter network to frequencies less than 500 Hz.

Humans also perceive and react differently to impulsive and continuous noise events depending on the sound pressure level (dB), frequency, and duration of the event. Because of the difference in human response to these types of noise events, military noise is commonly assessed using several sound level descriptors depending on the character and type of noise. The two most commonly used metrics are the time averaged sound pressure level (L_{eq}) and the peak sound pressure level (L_{pk}). Other metrics used include the maximum sound pressure level, L_{max}, and the day-night average sound level, Ldn. Time weighted and maximum sound level metrics are measured using A-weighting, and L_{pk} is measured using C-weighting. In some countries the C-weighted Ldn is used to account for the dominance of low frequency sound from weapon firing (see Appendix B). For land use planning purposes, Ldn is usually averaged over a year to reflect the varying periods of light and heavy training loads, as well as periods with no activity. The Ldn metric includes a 10 dB weighting for any events that occur during the period 2200-0700h. This means that a single noise event that occurs at night is assessed as the equivalent of ten daytime noise events of the same magnitude. This approach penalises or ensures a more conservative assessment for noise that occurs at night.

2.2 Weapon noise

Noise sources from military weapon firing and use of explosives include:

- Projectile noise and blast noise from in-use weapons (such as the noise of detonating propellant from a gun or 'muzzle' blast); and
- noise of detonating shells or other explosive devices.

Impulsive noise events are associated with the firing of weapons systems and the detonation of shells or explosives. These events often cause high magnitudes of peak or maximum sound pressure, and have relatively short-durations. The rapid onset of high intensity sound energy associated with such events, along with other distinguishing characteristics, can give rise to a more exacerbated subjective human response when compared to steady state or anonymous noise sources over the same assessment period.

[2] At normal conversational levels of sound – e.g. in the range 60-75 dB(A).

Weapons have a well-defined directivity with sound levels varying around the weapon. For example, a rocket propelled grenade generates the most sound energy behind the weapon, whereas with traditional armoury and small arms the prominent directivity is on axis and in front of the weapon's muzzle. The direction of firing can be an important factor when managing noise effects.

Unlike an industrial activity, noise from a weapon range is not continuous and comprises periods of noisy events when training takes place. These noisy events can comprise single, identifiable noise events (such as single shots) as well as periods of repetitive noise when automatic firing takes place, especially with machine guns and when there are multiple weapons being fired at a time. For most of the time weapon ranges are very quiet.

The management of military range noise varies internationally. Appendix B provides an overview of the approaches adopted in the United Kingdom and the United States.

2.3 Temporary military training activities

Within New Zealand NZDF uses the C-weighted peak sound pressure level (L_{Cpeak} / L_{Cpk}) to assess the extent of noise that is considered reasonable from temporary military training activities (TMTA) involving the use of weapons and explosives. Unlike the UK and US, limits have been established based on use of small calibre weapons (rifles and machine guns), 40 mm grenades and small explosive charges. Limits for both day time and night time have been established using the C-weighted peak sound pressure level, L_{Cpk}, and reflect a conservative level of noise effects which is unlikely to result in the occurrence of unreasonable noise as defined in Section 16 of the Resource Management Act 1991 (RMA), i.e. noise that unreasonably interferes with the peace, comfort and convenience of any person.

The daytime peak sound pressure limit set out in NZDF's recommended permitted activity noise standards is 95 dB L_{Cpk} and the night time limit is 10 dB lower at 85 dB L_{Cpk} when assessed at or within the notional boundary of any noise sensitive activity. These limits are significantly lower than similar limits adopted by the US when determining the risk of complaints from the use of large calibre weapons. They are also lower than the peak sound pressure level of 120 dB L_{Cpk}, set out in NZS 6801:2008 Acoustics – Measurement of Sound. The peak sound pressure level of 120 dB L_{Cpk} is typically the limit set out in district plan permitted activity standards and is well below the sound level that may cause building damage[3].

2.4 Military range noise

NZDF's separate day time and night time limits only apply to TMTA and are not intended to manage the noise effects from established ranges such as West Melton, as there is no indication of the quantum of noise that is experienced from training areas which are regularly used throughout the year. In these situations an exposure based sound level indicator is appropriate rather than a single-event metric.

The use of exposure based sound level descriptors based on the Ldn provides an indication of the frequency of events and penalises the occurrence of night time activity. Exposure based metrics are calculated using the sound exposure level (SEL / L_{Ae}) of a typical noise event and the number of events which occur during the day and night time periods (0700 to 2200h and 2200 to 0700h respectively).

Large-calibre guns will generate higher proportions of low frequency energy compared to smaller calibre weapons. For ranges which use larger calibre weapons, C-weighted sound level descriptors are preferred as used by the US. However in New Zealand, the use of the A-weighted Ldn is

[3] AS 2187:Part 2 Explosives—Storage and use Part 2: Use of explosives 2006.

appropriate due to the much lower levels of low frequency sound. This applies to rifle ranges such as West Melton which use light weapons.

3 Noise Standards and Land Use Planning

Within New Zealand there are no community noise significance thresholds used to rate the 'nuisance' from weapon firing ranges. However, there are a number of New Zealand standards which have adopted the Ldn and established 'significance' thresholds for land use planning purposes. These standards apply to noise from aircraft (NZS 6805:1991), helicopters (NZS 6807:1994) and ports (NZS 6809:1999). Similar procedures have been used to establish thresholds for range noise.

The aircraft, helicopter, and port noise standards require mitigation measures when the day-night average sound level in a residential community exceeds 55 dBA Ldn. For areas subject to 65 dBA Ldn or more, new noise-sensitive activities should be prohibited activities, as adverse noise effects will occur.

The level of 65 dBA Ldn corresponds to the threshold at which approximately 20% of the exposed population would be highly annoyed by sources of environmental noise and 55 dBA Ldn is the approximate onset threshold of significant community annoyance. Hence, 55 dBA Ldn is the annoyance threshold above which the effects could be considered to be significant and warrant land use planning restrictions. Greater than 65 dBA Ldn is generally found to be unacceptable for residential and other sensitive land uses. These annoyance thresholds have been applied to range noise at WMRR.

The aircraft, helicopter, and port standards recommended that new noise-sensitive activities should not be located in land subject to 65 dBA or more. For new or modified buildings subject to 55 to 65 dBA Ldn, acoustic insulation should be included within the building envelope to ensure acceptable levels of indoor amenity.

We have updated the contours prepared by MHA for 55 dBA Ldn and 65 dBA Ldn.

4 West Melton Rifle Range

4.1 Training activities

WMRR is used for small arms weapon training using live and blank ammunition. Figure 4.1 shows the location of the range and the firing points.

Figure 4.1: WMRR site location and firing locations.

There are four main sources of noise:

- Weapon firing on the Wooster A & B ranges including MARS (Modular Assault Rifle System – Light 5.56 calibre) and GPMG (general purpose machine gun – 7.62 calibre);
- Grenade training on the designated grenade range, including use of thunderflashes;
- 40 mm mortar firing; and
- Controlled detonations of high explosives, not exceeding 680 grams (e.g. M18 claymore mine).

The Wooster ranges have multiple firing positions as detailed in Table 4.1.

Table 4.1: Wooster ranges

Range	Firing positions / m
Wooster A	20, 100, 200, 300
Wooster B	30, 50, 100, 200, 300, 400, 500, 600

The range is used according to NZDF's training needs. MHA produced a noise model for NZDF of the rifle range in 2010 and estimates of range usage were included within the noise model. Table 4.2 and Table 4.3 detail the inputs used in the model.

Table 4.2: Weapon / firing usage

Activity	Estimated future firing
Single shot 5.56 mm	All daylight hours – 6 days/week
Group shot 5.56 mm	All daylight hours – 4 days/week
GPMG single burst (7.62 mm)	All daylight hours – 2 days/week
GPMG rapid fire (7.62 mm)	All daylight hours – 2 days/week

Table 4.3: Activity usage

Noise source	Activity level per annum
5.65 mm	700,000
7.62 mm	500,000
Grenade	20,000
40 mm	1,100
Detonation (0.5 kg equivalent)	50

These activity levels are based on future levels of range usage as referenced in the MHA report and NZDF has confirmed these remain relevant.

The 5.56 mm and 7.62 mm weapon firing takes place over a number of firing positions on the Wooster A and B ranges. Night time use of the range takes place approximately 20 times per year, mainly on the Wooster Ranges, which are protected by earth bunds. Very few grenades are used at night, although some training does occur with thunderflash grenade simulators.

The assessment also includes an allowance for use of the Barrett sniper rifle which has recently been procured by the Army. This rifle would be used at the 600 m firing point on the Wooster B range.

4.2 Noise modelling

A SoundPLAN version 8.1 computer noise model of the Range and wider area was constructed. The model incorporates 1 m resolution LiDAR terrain data. The surrounding buildings and the shielding properties of these buildings have been included within the model. A ground absorption factor of 1.0 has been used; the study area is predominantly soft (grass). Calculations have been undertaken in accordance with ISO:9613-2[4], which allows for downwind sound propagation or equivalently, propagation over a well-developed moderate ground based temperature inversion, such as commonly occurs at night.

Source sound levels for each of the firing points have been included within the model according to the anticipated range usage as shown in Table 4.2 and Table 4.3. Source levels expressed as sound power level, L_w, vary from 95 to 158 dB, depending upon the weapon type and usage over an annual period (based on 42 weeks range use per year) and the time of day.

Noise contours have been produced based on the Ldn sound level descriptor using 65 dB and 55 dB threshold levels (refer Section 3 for basis of these levels).

[4] ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation.

4.3 Validation

Validation and calibration of the WMRR SoundPLAN model was undertaken using measured data recorded by MHA and additional data collected in August 2019. Receiver locations were entered into the model and source level contributions were calculated at each location.

The 2019 sound level measurements were undertaken by T+T during an army exercise which was held at the range between Saturday 31 August and Sunday 1 September 2019. A 01dB Fusion sound level meter was used to record receiver sound levels. Measurements were undertaken under satisfactory meteorological conditions, i.e. no precipitation, light to no wind (less than 1m/s) and clear cloud cover. Single and multiple rifle firing was carried out on the Wooster ranges. Both single shot and rapid burst firing was conducted. Subjective observations were recorded. Full results are available. The purpose of the measurements was to collect receiver noise levels at a number of locations outside the range boundary for known activity on the range. All data were then compared against predicted sound levels from the WMRR noise model.

Receiver sound levels expressed as single event levels, L_{Ae}, were found to be within 2 to 5 dB of the model results and hence the model's input data was modified to match the measured data. After calibration of the model the difference between the levels was less than 2 dB which is considered satisfactory for noise modelling purposes.

4.4 Results

The WMRR SoundPLAN noise contour is comparable in size and shape to the MHA report. However source data for the new weapon types has resulted in a lengthening of the outer noise control boundary contour to the south of the range in the vicinity of Halkett Road/Weedons Ross Road.

The 55 dBA Ldn outer noise control boundary and the 65 dBA Ldn inner control boundary are provided at Appendix C.

These contours should replace the preliminary MHA contours provided to SDC.

5 Applicability

This report has been prepared for the exclusive use of our client New Zealand Defence Force, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that this report will be used by Selwyn District Council in undertaking its planning and regulatory functions in connection with the West Melton Rifle Range.

Tonkin & Taylor Ltd

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
	
.....	.....
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DAHU
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Appendix A: Glossary of Terms

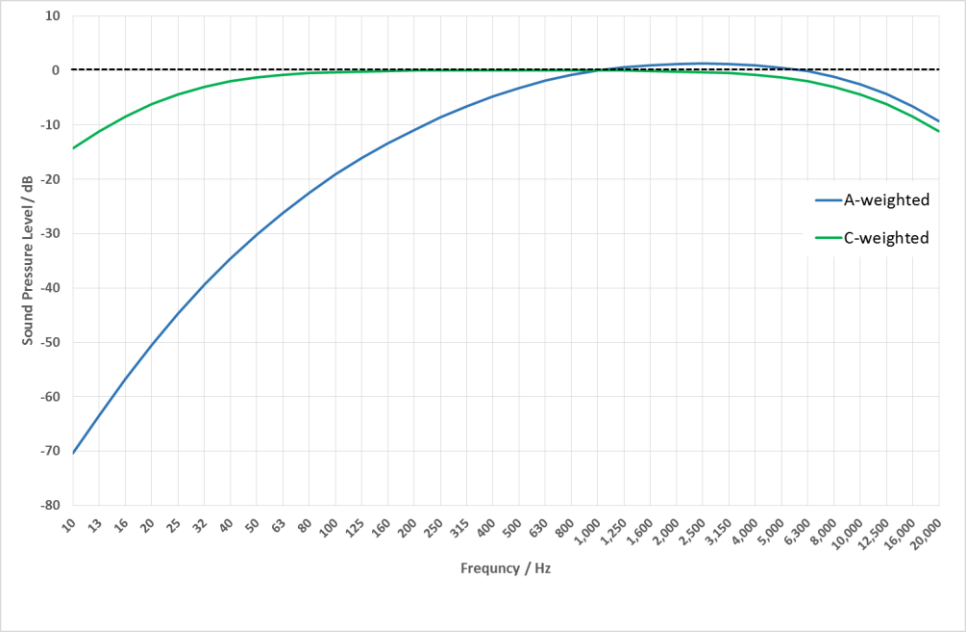
Term	Definition
CDNL	C-weighted day-night average noise level.
Decibel (dB)	A unit of measurement on a logarithmic scale which describes the magnitude of sound pressure with respect to a reference value (20 µPa).
Hertz (Hz)	Unit of frequency – the number cycles per second of a wave form.
Impulse	Transient sound having a peak level of short duration, typically less than 100 ms.
Infrasound	Sound below the normal audible hearing frequency range of the average person – usually less than 20 Hz in frequency.
$L_{Aeq(t)}$	The A-weighted time-average sound level over a period of time (t), measured in units of decibels (dB).
L_{Amax}	The maximum A-weighted sound pressure level over a period of time or of a particular noise event, measured in units of decibels (dB).
L_{Cpk}	The C-weighted maximum absolute instantaneous sound pressure level.
Ldn	The A-weighted time weighted average sound level over a period of 24 hours after the addition of 10 decibels to sound levels measured during the night (2200-0700).
$L_{Aeq,t}$	The A-weighted time weighted average sound level over a period of time, t.
L_w / SWL	Sound power level of a source, measured in decibels (dB).
SEL / L_{Ae}	Sound exposure level – the A-weighted sound pressure level which is maintained constant for a period of one second would contain the same sound energy of a given noise event.
Noise	Unwanted sound.
Notional boundary	A line 20 metres from any side of a dwelling or the legal boundary where this is closer to the dwelling.
PK_{15}	peak sound pressure level exceeded for 15% of the time.
SAC	Special audible characteristics – a sound that has a noticeable quality.
TMTA	Temporary military training activities.

Every 10 dB increase in sound level doubles the perceived noise level. A sound of 70 dB is twice as loud as a sound level of 60 dB and a sound level of 80 dB is four times louder than a sound level of 60 dB. An increase or decrease in sound level of 3 dB or more is perceptible. A change in sound level of less than 3 dB is not usually discernible.

As sound levels are measured on a logarithmic scale, the following chart provides examples of typical sources of noise.

Decibel (dB)	Example
0	Hearing threshold
20	Still night-time
30	Library
40	Typical office room with no talking
50	Heat pump running in living room
60	Conversational speech
70	10 m from edge of busy urban road
80	10 m from large diesel truck
90	Lawn mower - petrol
100	Riding a motorcycle at 80 kph
110	Rock band at a concert
120	Emergency vehicle siren
140	Threshold of permanent hearing damage

Relationship between A-weighted and C-weighted sound levels is shown in the following graph. A linear level (also known as Z-weighted level, un-weighted level or flat response) is represented by the dashed line. The A-weighted value of a noise source is an approximation to how the human ear perceives the noise. For sounds having a strong low frequency component the C-weighted levels will be greater than A-weighted value by more than 10 dB.



Appendix B: International Experience

Management of weapon noise

In the United Kingdom, the Ministry of Defence (MoD) aims to protect members of the public from the effects of noise and vibration generated by military training activities, whilst maintaining the effective operation of its armed forces for the interests of national security. The MoD has committed that '*private dwellings and areas of public use adjacent to military areas will not be subjected to impulse noise above 130 decibels*'[5]. There is no recommendation on the quantum of noise that people can experience although the MoD is committed to ensuring that individuals are not exposed to average sound levels that may cause hearing loss, i.e. a daily noise exposure level of 80 dB(A).

In the United States, the US Department of Defense (DOD) noise working group recommends the use of the C-weighted day-night average noise level (CDNL[6]) for noise exposure analysis and mapping of military range noise, except for small arms. In addition, the DOD establishes supplementary noise contours based on the PK_{15} noise metric, which is the peak sound pressure level exceeded for 15% of the time. The DOD threshold limits are shown in Table B.1, in which Zones I-III refer to the level of noise exposure experienced and the sensitivity of the zone to noise. Zone I being more sensitive to noise than Zone III.

Table B.1: US DOD noise limits for noise zones

Noise Zone	**Impulsive CDNL**	**Small arms – PK_{15}**
Land use planning zone	57 – 62	N/A
I	< 62	< 87
II	62 – 70	87 – 104
III	> 70	> 104

The US Army uses the PK_{15} noise metric to assess the likelihood that noise complaints will occur from the use of large calibre weapons. The threshold for a high risk of complaint is comparable to the UK MoD L_{pk} of 130 dB (taking into account the slight differences between PK_{15} and L_{pk}). The relationship between risk and noise is shown in Table B.2 below.

Research conducted by Sorenson and Magnusson[7] found that a mean unweighted peak sound pressure level around 85 dB Lpk is a reasonable criterion for land use-planning and at this level approximately 10% of a residential population would be expected to be affected. Further findings are provided in Table B.3.

Both the US DOD and UK MoD have produced peak noise contours to illustrate the extent of impulsive noise for land use planning purposes or for establishing the extent of noise disturbance prior to undertaking military training[8]. However these contours do not convey how often military training is heard or the cumulative effects of noise which are helpful when understanding a community's long term reaction to training noise. To overcome the limitations of peak contours, exposure based contours have been used to good effect in the US to illustrate both the level of noise and the quantum of noise (as established from the number of events or duration of noise). These contours are based on the C-weighted Ldn to reflect the low frequencies produced by large calibre weapons. For small calibre weapons which do not produce significant levels of low frequency noise the A-weighted Ldn would also be appropriate.

[5] Otterburn Training Area: AS90 Firing Plan HL Deb 01 February 1995 vol 560 cc114-5WA.
[6] The CDNL is the same as the C-weighted L_{dn}.
[7] Sorenson and Magnusson, 'Annoyance caused by noise from shooting ranges', Journal of Sound and Vibration, Vol 62, 437-442, 1979.
[8] https://www.casltd.com/view-service/noise-analysis-tool.

Table B.2: US Army risk of noise complaints (large calibre)[9]

Risk of noise complaints	Noise limits – PK15 dB
Low	<115
Medium	115 - 130
High	130 -140
Risk of physiological damage	> 140

Table B.3: Percentage of population highly annoyed from small arms range noise

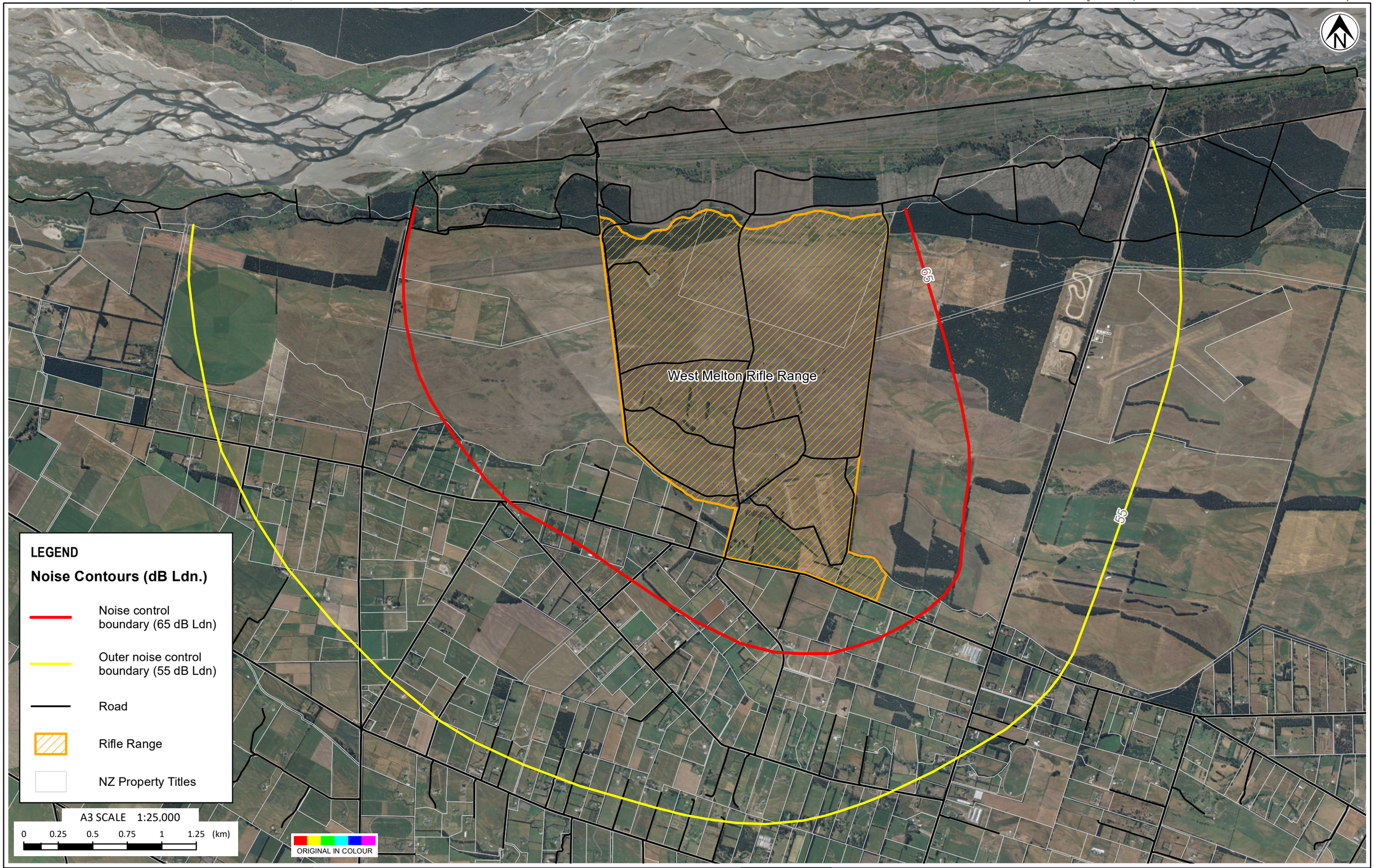
Peak Level, L_{pk} dB	Percentage Highly annoyed (%HA)
80	4
85	10
90	13
95	21
100	29
105	38

After Sorenson and Magnusson 1979.

[9] US DoD, Community and environmental noise: A guide for military installations and communities, December 2018.

Appendix C: West Melton Rifle Range – Noise Control Boundary

T:\Christchurch\TT Projects\1010541\WorkingMaterial\GIS\Map Documents\1010541-0000-MAP001.mxd 2019-Oct-03 3:41:40 PM Drawn by JJXC



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NOTES:

1. CANTERBURY 0.3M RURAL AERIAL PHOTOS 2015 TO 2016 SOURCED FROM THE LINZ DATA SERVICE AND LICENSED BY THE CANTERBURY AERIAL IMAGERY (CAI) CONSORTIUM FOR RE-USE UNDER CC-BY 4.0.
2. NEW ZEALAND TITLES AND ROAD CENTRELINES SOURCED FROM LINZ DATA SERVICE UNDER CC-BY 4.0.

REV	DESCRIPTION	GIS	CHK	DATE
0	FIRST VERSION	JJXC	EMSO	20/09/19

LOCATION PLAN

PROJECT No.	1010541.2000	
DESIGNED	JJXC	DEC.19
DRAWN	JJXC	DEC.19
CHECKED	EMSO	DEC.19
APPROVED		DATE

CLIENT NEW ZEALAND DEFENCE FORCE

PROJECT SELWYN DISTRICT PLAN REVIEW

TITLE NOISE CONTROL BOUNDARY
DRAFT FOR CONSULTATION

SCALE (A3) 1:25,000 FIG No. FIGURE 1. REV 0

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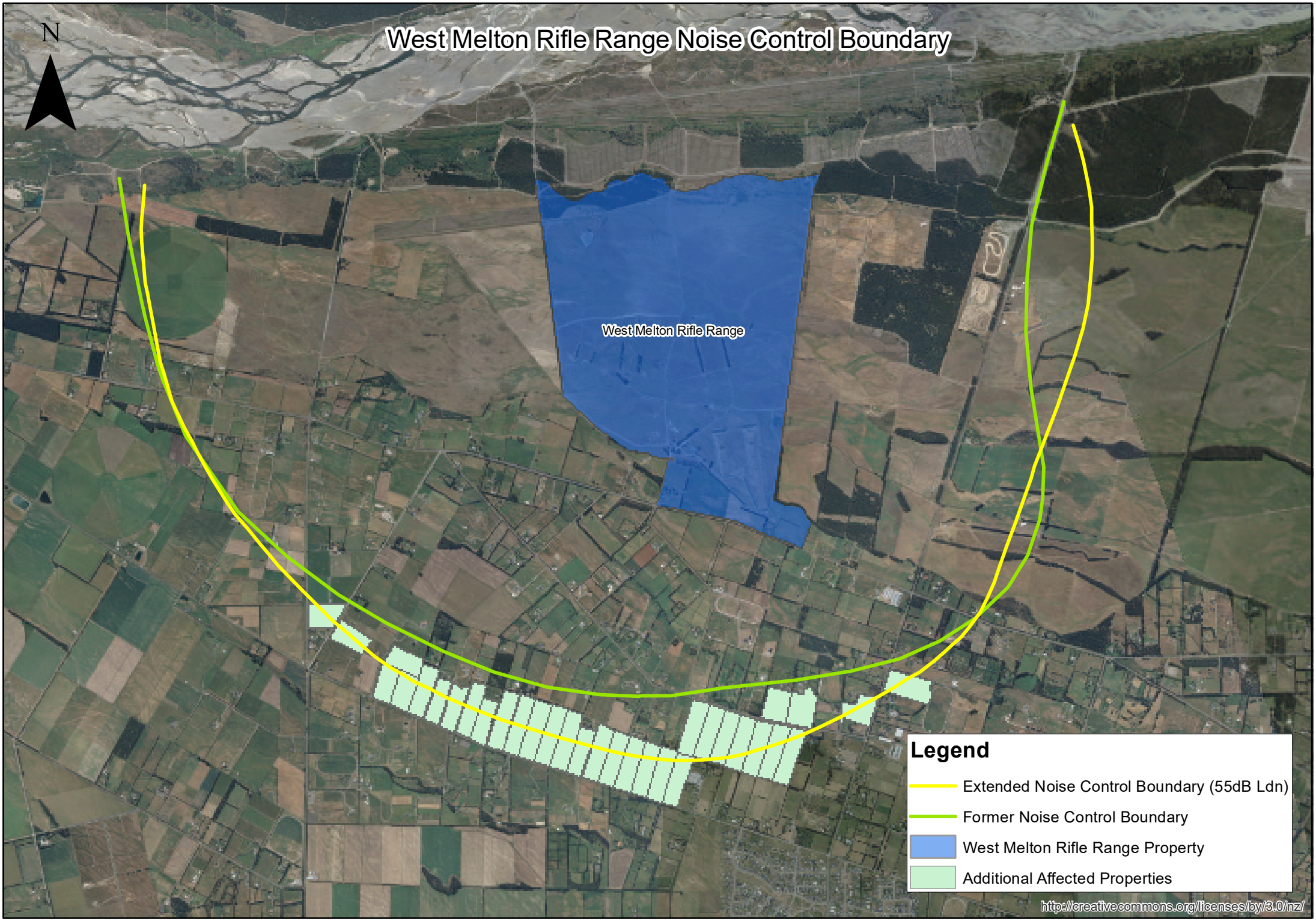
Appendix 2 – Comparison Map


N
West Melton Rifle Range Noise Control Boundary
West Melton Rifle Range
Legend
Extended Noise Control Boundary (55dB Ldn)
Former Noise Control Boundary
West Melton Rifle Range Property
Additional Affected Properties
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