

Memorandum

To: Brittany Ratka, Christchurch City Council

CC: Ike Kleynbos, Christchurch City Council

From: Jeremy Trevathan, Acoustic Engineering Services

File Reference: AC22386 – 03 – R2

Date: Tuesday, 7 February 2023

Project: CCC Proposed Plan Change 14 – Industrial-Residential interface
Review of potential buffer size

Pages: 28

Meeting Telephone Memorandum File Note

Dear Brittany,

We have previously undertaken a review to determine whether the current Christchurch District Plan (CDP) noise limits are sufficient to address residential development adjoining Industrial zones which would be enabled by Plan Change 14 (PC14), and provided preliminary recommendations. Our analysis and findings were outlined in our report titled *CCC Proposed Plan Change 14: Industrial-Residential interface – Review of potential noise issues* (AES file reference: AC22386 – 02 – R3), and dated the 20th of January 2023.

You subsequently advised us that the Christchurch City Council (CCC) is considering progressing a Qualifying Matter in the form of a buffer restricting building height in residential areas, while leaving the current acoustic controls on industrial sites as is. Consent for three storey residential development within the buffer could be applied for. It would need to be demonstrated that the development would not unduly impact on the adjoining Industrial zone (such as by providing acoustic insulation). Reference was initially made to the 120 metre figure mentioned in section 6 of our 20 January 2023 report.

We provided further advice via email confirming that in the example discussed in section 6 of our 20 January 2023 report, the industrial noise source would need to be currently operating right at the residential boundary for a 120 metre buffer to be required and/or the intervening houses (where the buffer extends two or three sites deep into the residential area) are likely to provide enough ‘ad-hoc’ screening in many situations. We suggested in many real-world arrangements, a smaller buffer – in the order of 40 metres, may be appropriate and that in some arrangements where industrial noise sources are not currently screened from the residential receivers, it would make no difference whether the dwellings were single or three storeys (i.e. no buffer would be required).

We have now been engaged to undertake three-dimensional modelling work, to examine various real-world and hypothetical scenarios and determine what can be concluded about the potential appropriate size for a buffer designed to prevent three storey dwellings being constructed in inappropriate arrangements at the Industrial-Residential interface.

Please find our further analysis and recommendations below.

1.0 BACKGROUND

At the outset of our original review, we had identified the potential for the upper levels of new three storey houses which would be enabled by PC14 to overlook industrial areas, whereas lower houses were screened. In that situation, in line with NZS6802:2008, the upper façade would now become a noise compliance assessment location. If noise levels exceeding the CDP limits were received at that upper façade because it had more direct line of sight to industrial activities, it is not clear how the situation would be resolved. If the industrial activity was not required to reduce its noise emissions, those occupying the upper level of the new dwelling could be exposed to inappropriately high noise levels.

As discussed in detail in our 20 January 2023 report, industrial activities are required to comply with the residential noise limits when received within the Residential zone. This currently results in two possible locations where compliance should be assessed in accordance with NZS6802:2008:

1. Where there is an existing single level building on a residential site, the industrial noise source needs to comply at 1.2 – 1.5 metres above ground level over the entire outdoor area of the site (i.e. including right up to the common boundary).
2. Where there is an existing two-level building on a residential site, compliance is also assessed at the upper-level façade, 1.2 – 1.5 metres above the ‘floor level of interest’. That assessment location may be set back from the boundary, depending on where on the site the second storey of the dwelling is located, and approximately 4.5 metres in the air.

Our site visits indicated that the vast majority of existing dwellings at the Industrial-Residential interface are single storey (compliance situation 1 above). However, we understand that these sites could be redeveloped for two storey dwellings under the current planning rules (meaning compliance situation 2 above would then also be relevant). We understand that PC14 may provide further incentive to redevelop those sites, and that new dwellings in that case may be up to three stories.

As the dwelling height increases, industrial sources are less likely to benefit from screening provided by intervening structures. As described in our original report, a real-world example of this which we observed during the site visits was a ground level industrial noise source such as a forklift which currently operates 20 metres from the Industrial-Residential interface, with a single level residential dwelling situated 5 metres from the site boundary. The dwelling is currently screened by a small intervening single-level industrial building (approximately 3 metres in height) located in the Industrial zone. Compliance with the CDP daytime 50 dB L_{Aeq} limit would just be achieved in that scenario. If the neighbouring dwelling was increased to two stories, noise levels of 55 to 60 dB L_{Aeq} may be experienced at the upper-level facade. If the neighbouring dwelling was increased to three stories, noise levels of over 60 dB L_{Aeq} may be experienced at the upper-level facade. To ensure continued compliance with a 50 dB L_{Aeq} limit in that scenario, a two-storey dwelling would need to be set back at least 70 metres from the forklift (i.e. 50 metres from the Industrial-Residential interface), and a three-storey dwelling would need to be set back at least 120 metres from the forklift (i.e. 100 metres from the Industrial-Residential interface) if there was no other intervening screening within that buffer area. Given many residential sites are 40 metres ‘deep’, it is likely that some screening would be provided by intervening dwellings, in that scenario.

As above, we have now conducted detailed three-dimensional modelling to examine the likely required buffer distances, when a variety of factors and arrangements are taken into account.

2.0 METHODOLOGY

We have completed SoundPlan computational noise modelling for a variety of different scenarios based on a selection of real sites in Christchurch. These sites were selected to examine a range of circumstances which actually exist at the Industrial-Residential interface, including:

- A range of industrial areas – Belfast, Hornby-Hei Hei, Hornby Central, Wainoni and Woolston

- Various scenarios with regard to existing screening between source and receiver – for example, some situations where industrial sources are screened by buildings, some situations where industrial sources are screened only by fencing at the Industrial-Residential interface, other situations where there is partial screening by buildings and/or fencing, and situations where there is no screening

The area generally covered by each of the models is shown in figures 2.1 to 2.5 below. The actual currently-existing industrial buildings were used in the model, to ensure the layout of the industrial sites and height of buildings and other screening was realistic.



Figure 2.1 – Belfast location



Figure 2.2 – Hornby-Hei Hei location

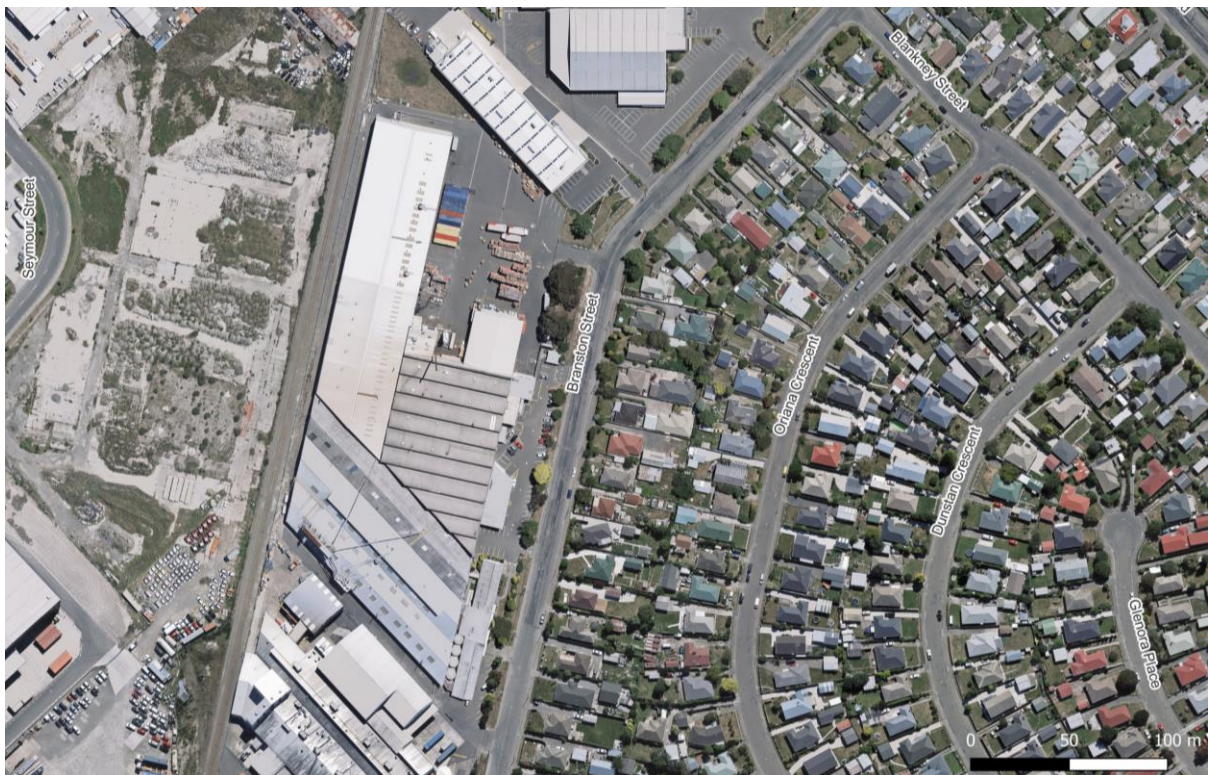


Figure 2.3 – Hornby Central



Figure 2.4 – Wainoni



Figure 2.5 – Woolston

The industrial noise sources used in the model were however hypothetical (but realistic) with regard to the exact sound powers and locations on site assumed. Hypothetical sources were necessary to efficiently examine the buffer distance question, as arrangements were needed where the industrial sources experienced a range of types of screening, and in all cases 'just complied' with the CDP noise limits at ground or second floor level. As discussed on our original report, in reality many industrial noise sources currently benefit from little screening and/or comply with the CDP noise limits by some margin.

Industrial noise sources were therefore modelled at 1 metre above ground level within various areas of the industrial sites. Based on the specific screening at each site, the noise source was adjusted to ensure complying daytime noise levels at the nearest residential property at ground and/or first floor level. For the modelled scenarios this resulted in a sound power of the noise source ranging from 94 to 105 dB L_{WA} . As outlined in table 3.2 of our original report, noise at this level could be representative of the following industrial activity:

- Large vehicles (100 – 110 dB L_{WA})– container handling equipment, large earthmoving machinery being loaded
- Medium scale equipment (95 – 100 dB L_{WA}) – compressors, typical forklifts, loading drainlayers excavator onto a truck
- Hand-held equipment, typical of 'service' businesses (90 – 95 dB L_{WA}) – for example a small pneumatic ratchet

Noise sources with sound powers at the higher end of those ranges could also fit within the modelled envelope at every assumed location, if they were not continuous for an entire 15-minute assessment period or if a duration adjustment applied during the daytime period. Similarly, various other scenarios could exist such as:

- Noise sources could sometimes be located even closer to the Industrial-Residential interface than we have assumed in our scenarios, but comply with the CDP noise limits because they are intermittent.
- Noise sources could often be located higher above ground level than we assumed – which typically would need to be the same or lower sound power to comply with the CDP noise limits and/or experience less screening for all receiver heights.
- We have considered noise sources operating during the daytime only. If the industrial activity occurred during the night-time period (2200 to 0700 hours) the noise source would need to be reduced by 10 dB to comply with the CDP noise limit of 40 dB L_{Aeq} under the current layout scenarios. If this occurred, the extent of the 40 dB L_{Aeq} contour beyond the Industrial-Residential interface would be the same as the 50 dB L_{Aeq} contour during the daytime.

Overall, we expect that all of those possible variations would produce outcomes within a similar range to that already evident in our results, which are presented in section 3.0 below.

3.0 MODELLING RESULTS

We have structured our results into three groups, as follows:

1. Situation 1 – Implications at third floor level of an industrial source which currently complies with the CDP noise limits at 1.5 metres above ground level within the Residential zone, due to screening provided by intervening structures.
2. Situation 2 – Implications at third floor level of an industrial source which currently also complies with the CDP noise limits at 4.5 metres above ground level (second floor level) within the Residential zone, due to screening provided by intervening structures.

3. Situation 3 – Implications at third floor level of an industrial source which currently complies with the CDP noise limits due to distance alone – i.e. it does not currently benefit from screening provided by intervening structures.

Our findings for each situation are discussed below.

3.1 Situation 1 – An industrial source which currently complies with the CDP noise limits at 1.5 metres above ground level within the Residential zone

As outlined above, our site visits indicated that the vast majority of the dwellings at the Industrial-Residential interface are currently single storey. In this situation, in the majority of layouts observed there was screening blocking direct line of sight between many industrial source and residential properties – either provided by buildings, or site fencing.

The effectiveness of screening depends on the height of the screen, as well as the location of the screen relative to the source and the receiver. The key issue in this case is that if the height of the receiver is increased from 1.5 metres above ground level to approximately 7.5 metres above ground level (the third-floor level of a dwelling), the effectiveness of any screening may be reduced. If there is now direct line of sight between the source and receiver, the screening may reduce to zero. In that case, a noise source which is relying on the screening to comply with a noise limit of 50 dB L_{Aeq} at ground level, would generate a noise level above 50 dB L_{Aeq} when received at the third-floor level of the new dwelling.

In order to determine how far this elevated noise area may extend beyond the Industrial-Residential interface we have modelled a number of different scenarios based on the observed site layouts, as discussed above. The results are summarised in table 3.1. The associated noise contour plots can be found in Appendix A.

Table 3.1 – ‘Situation 1’ analysis summary

Modelling scenario (refer Appendix A.1)	Industrial area used as basis for the model	Summary of screening situation	Distance from industrial source to residential boundary (metres)	Maximum extent of elevated noise area into the Residential zone, at third floor level (metres)
Where ground level screening is provided by a building				
1	Hornby-Hei Hei	3 m high building and 1.5 m boundary fence	41	36
2	Belfast	3 m high building and 1.5 m boundary fence	40	43
3	Woolston	3 m high building and 1.5 m boundary fence	60	40
Where ground level screening is provided by a fence				
4	Hornby-Hei Hei	1.5 m boundary fence	88	33
5	Wainoni	1.5 m boundary fence	35	15
6	Wainoni	1.5 m boundary fence	70	25
Where there is only partial screening at ground level				
7	Hornby Central	Partial screening from 3 m high building and 2.5 m high wall	80	29
8	Woolston	Partial screening from 3 m high building and 1.5 m boundary fence	44	15

As shown in table 3.1 above, the extent of the elevated noise area at the third-floor level height depends on the site layout, how much screening is currently being provided, and the distance between the source and the residential boundary. However, generally if the source is currently being fully screened at ground level by a building, the elevated noise area extends approximately 40 metres into the Residential zone. If there is currently less screening at ground level (e.g. fence only, or partial screening) the elevated noise area extends 15 – 30 metres into the Residential zone.

3.2 Situation 2 – An industrial source which currently also complies with the CDP noise limits at 4.5 metres above ground level (second floor level) within the Residential zone

As outlined above, where there is an existing two-storey building on a residential site, when assessed in accordance with NZS 6802:2008 the industrial noise source needs to comply with the CDP limits at the upper level façade. This is a different ‘existing’ scenario to that presented in 3.1 above, as the difference between what is required to comply at second floor level, and what is required to comply at third floor level, is not as great (compared to a change from ground floor level to third floor level).

Therefore, we have re-modelled the same scenarios outlined above, however we have adjusted the noise sources such that the ‘existing’ situation involves industrial noise sources which currently comply with the

CDP limits at both ground and second floor. The results are summarised in table 3.2. The associated noise contour plots can be found in Appendix B.

Table 3.2 – ‘Situation 2’ analysis summary

Modelling scenario (refer Appendix A.1)	Industrial area used as basis for the model	Summary of screening situation	Distance from industrial source to residential boundary (metres)	Maximum extent of elevated noise area into the Residential zone, at third floor level (metres)
Where ground level screening is provided by a building				
1	Hornby-Hei Hei	3 m high building and 1.5 m boundary fence	41	6
2	Belfast	3 m high building and 1.5 m boundary fence	40	17
3	Woolston	3 m high building and 1.5 m boundary fence	60	13
Where ground level screening is provided by a fence				
4	Hornby-Hei Hei	1.5 m boundary fence	88	0
5	Wainoni	1.5 m boundary fence	35	0
6	Wainoni	1.5 m boundary fence	70	0
Where there is only partial screening at ground level				
7	Hornby Central	Partial screening from 3 m high building and 2.5 m high wall	80	16
8	Woolston	Partial screening from 3 m high building and 1.5 m boundary fence	44	0

This analysis indicates that where there is a building between the noise source and the dwellings some shielding is still being provided to the second-floor level of dwellings – and so the increase to third floor level does lead to an elevated noise area extending between 5 and 20 metres into the Residential zone. Where the screening was more ad-hoc (only partially screened), or from a low fence, there may already be direct line of sight between the source and the second level of the dwelling – and so the increase in height to third floor level makes no difference.

3.3 Situation 3 – An industrial source which currently complies with the CDP noise limits due to distance alone

A relatively common situation is where there is currently no screening between an industrial source and a residential property – for example, where mechanical equipment is located on the roof of the industrial building. As the source is already elevated, the receiver height makes little difference to the noise levels received – and it is possible that lower noise levels could actually be received at the second and third storey facades, compared on the ground level. For example, if there was an item of mechanical plant located on

the roof of a building approximately 50 metres from the residential site boundary with direct line of sight, the source would need to have a sound power of 90 dB L_{WA} or less in order to comply with the CDP daytime noise limit of 50 dB L_{Aeq} at the boundary, at ground level. If the dwelling was two or three storeys in height and was located 10 – 20 metres setback from the boundary, the expected noise levels at the upper facades would be 47 – 48 dB L_{Aeq} due to the additional distance.

We have not modelled these scenarios specifically, but the minimal difference between the contours at ground floor and third floor level can be observed in figures 5.7.1 and 5.7.2, in the direction of noise propagation to the north-east, where there is no screening.

4.0 DISCUSSION AND CONCLUSIONS

We have considered numerous possible source / receiver arrangements at the Industrial-Residential interface, to examine situations where industrial noise which currently complies with the CDP limits would lead to elevated noise at the upper level of a future three level dwelling, potentially generating some direct noise effect on residential occupants or a potential noise reverse sensitivity effect for the industrial noise emitter.

There are numerous circumstances under which this issue would not arise such as:

- The industrial activities are low noise emitting, and comply with the CDP noise limits by a considerable margin, at all receivers' heights.
- The industrial noise sources are effectively screened, even when the receiver is a three-storey dwelling.
- The industrial noise sources are far from the interface (for example > 100 metres) and so receiver height makes relatively little difference,
- The industrial sources are closer to the interface but currently have little effective screening and so already have to manage their noise emissions, and so receiver height makes relatively little difference. A common example of this arrangement is when the residential and industrial areas are 'across the road' from each other - as they are unlikely to have solid, continuous fences to the road boundary, due to access requirements.

As per our 20 January 2023 report, along the majority of the Residential / Industrial interface, the situation and arrangement was observed to currently fall into one of the above categories.

Buffer area size

However, the additional modelling and analysis in this memo does demonstrate that there are realistic scenarios where the construction of three level dwellings would lead to elevated noise being experienced at the upper facade. Once real-world factors such as the screening provided by the dwellings themselves, and the probable arrangement of industrial sites is taken into account, the area within the Residential zone potentially affected is relatively modest – with:

- 40 metres potentially being a reasonable buffer distance if the situation of most concern is what might arise if neighbouring single level dwellings were replaced with three level dwellings, and
- 15 metres potentially being a reasonable buffer distance if the issue of concern is the difference between what might arise when two-storey dwellings are permitted, and what might arise if three level dwellings are permitted.

Our review suggests that if a buffer area was created within which further review was required before three level dwellings were constructed, this review process would occasionally identify and prevent an arrangement which would have otherwise proved to be problematic – and either lead to residents experiencing noise levels above guideline values, or industrial operations being restricted. From an acoustic

point of view, there would therefore be merit in such an approach. We expect planning input and analysis may be required to consider the appropriate balance between this benefit and the potential cost of subduing residential development within the buffer area in many situations which would not have proved to be problematic.

Implications for those wishing to construct three-storey dwellings in the buffer area

As outlined above, based on earlier correspondence, we understand that the CCC may be in favour of an approach which required those constructing three level dwellings in the buffer area to demonstrate that the development would not unduly impact on the adjoining industrial zone.

The appropriate response in each case will depend on the planning situation and interpretations – particularly with regard to the status of the industrial activity. If the industrial activity in question is able to continue generating elevated noise levels at the third storey of the new dwelling, an adequate response may be for the new dwelling to incorporate enhanced sound insulation, and ensure that outdoor living areas (balconies) do not face towards the industrial source. However, if it is determined that the industrial source would be obliged to reduce their noise emissions to comply with the CDP at the new third floor façade, the residential developer may have few ways forward, unless they engage with the industrial operator with a view to obtaining Affected Persons Approval.

Practical challenges with undertaking a review of the expected industrial noise emissions potentially received by a specific development

In many cases, a cursory site-specific evaluation may correctly conclude that current industrial noise levels are low at third floor level within the Residential zone, and comply with the CDP noise limits by a considerable margin at all receivers' heights. In those cases, the existence of the buffer would have introduced additional cost for the residential developer, as they would need to engage an acoustic engineer to undertake that assessment and report.

There are however various complexities which could arise in some situations, or for the CCC in processing Applications, such as:

- Thought would need to be given to whether only current existing industrial noise sources should be taken into account or whether the noise assessment should consider a 'maximum envelope' of permitted use of the industrial sites – including, for example, possible new sources, with less screening at third floor level.
- Even identifying 'existing industrial sources' may be challenging for an acoustic engineer engaged by a third-party residential developer – i.e. understanding what the neighbouring industrial businesses do, and when and how they may generate noise. Often noise emissions may be different day to day during the week, or periodic or seasonal – and that may not be obvious during a one-off site visit.

Ideally the CDP would provide direction on these type of issues where possible, and the CCC should develop a consistent approach to reviewing Applications they receive.

We trust this is of some assistance.

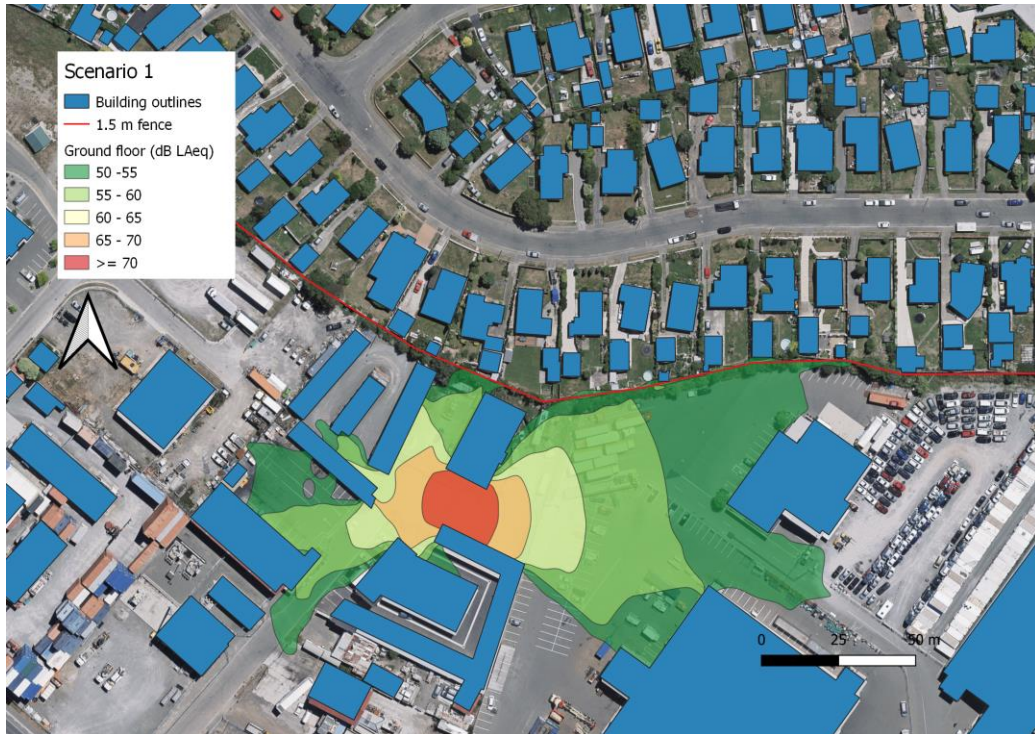


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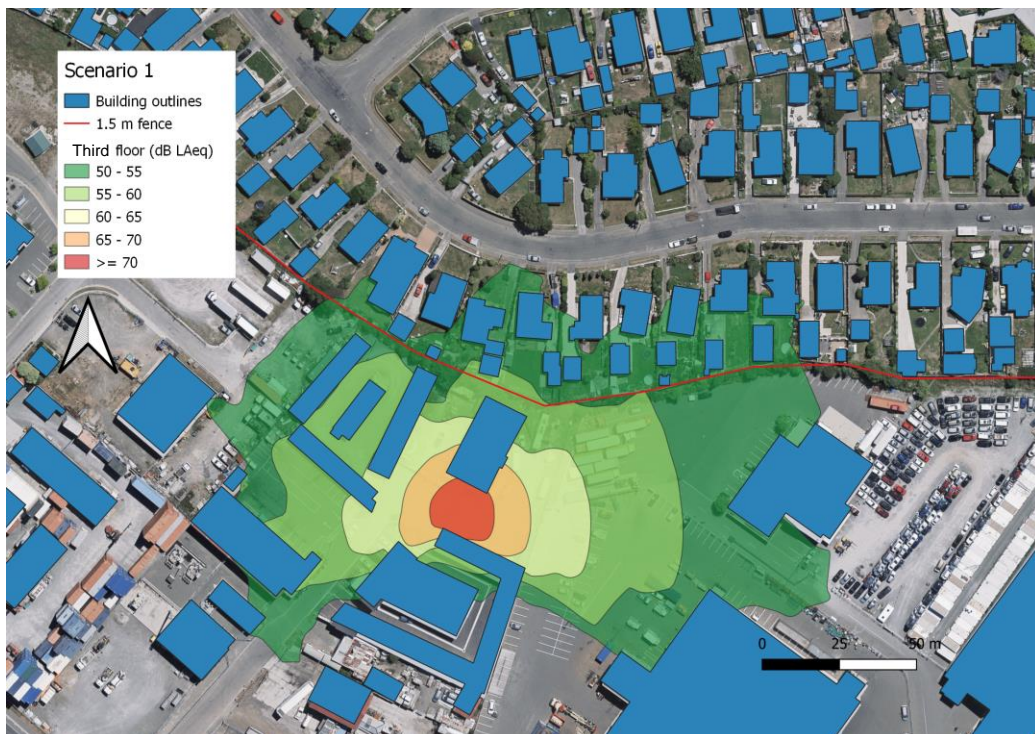
5.0 APPENDIX A – SITUATION 1

5.1 Scenario 1

5.1.1 Ground floor level Hornby Hei Hei



5.1.2 Third floor level Hornby Hei Hei

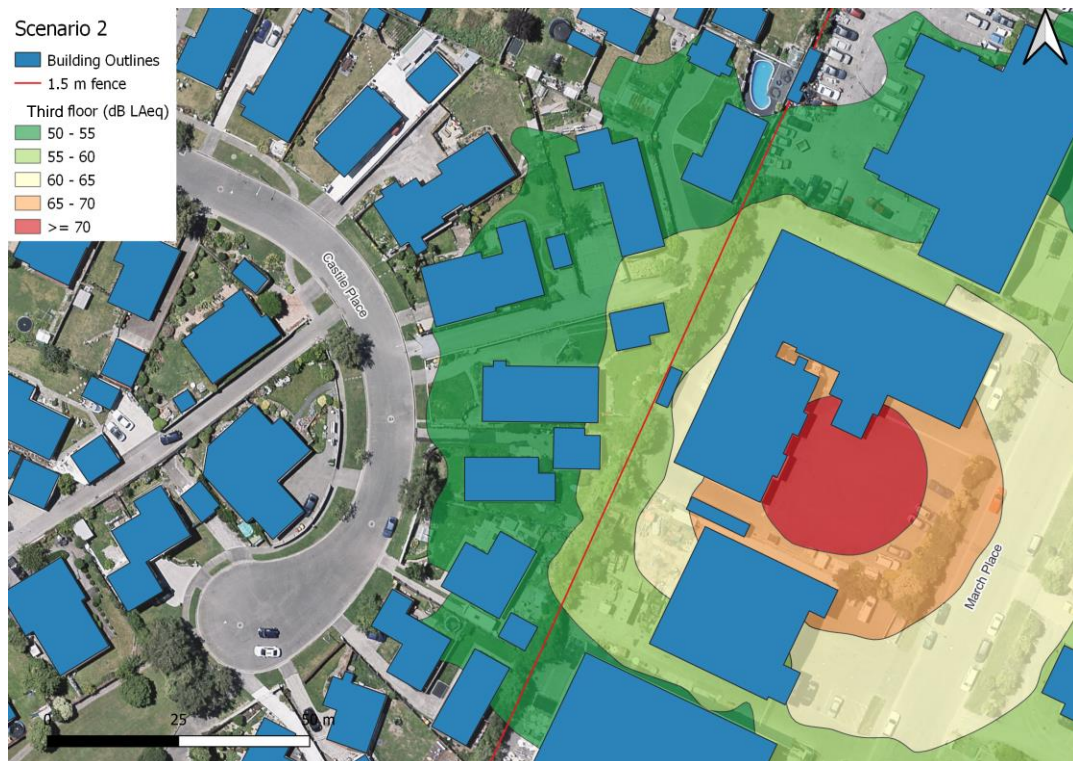


5.2 Scenario 2

5.2.1 Ground floor level Belfast

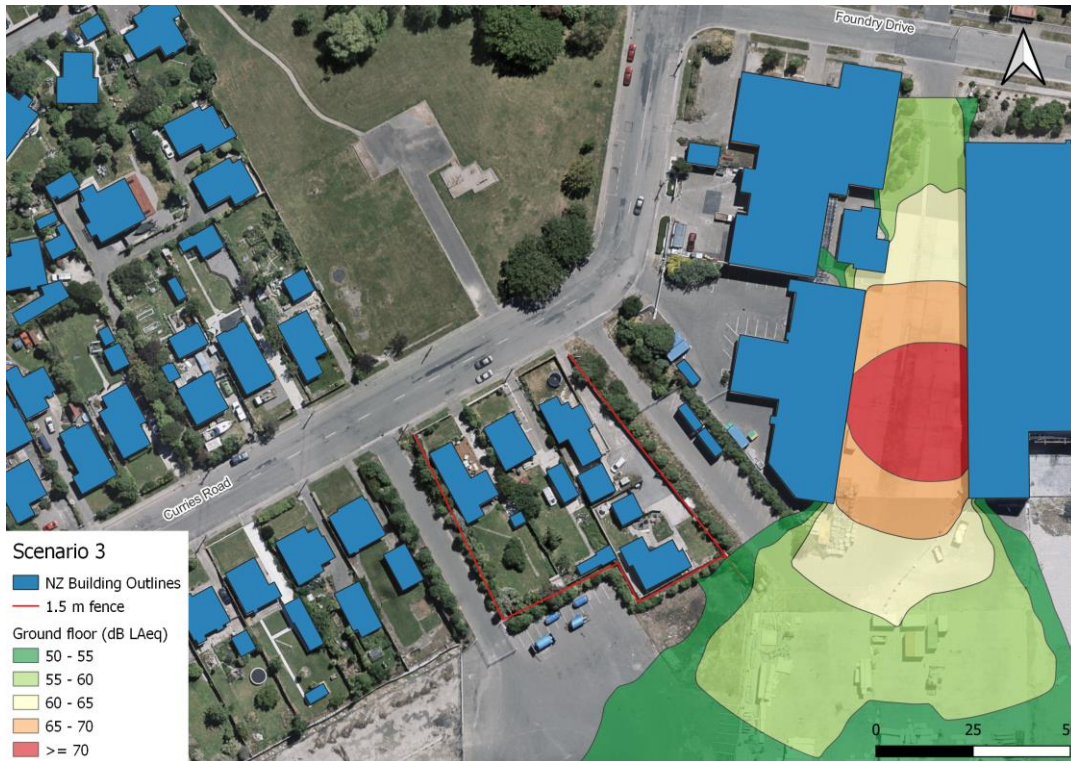


5.2.2 Third floor level Belfast

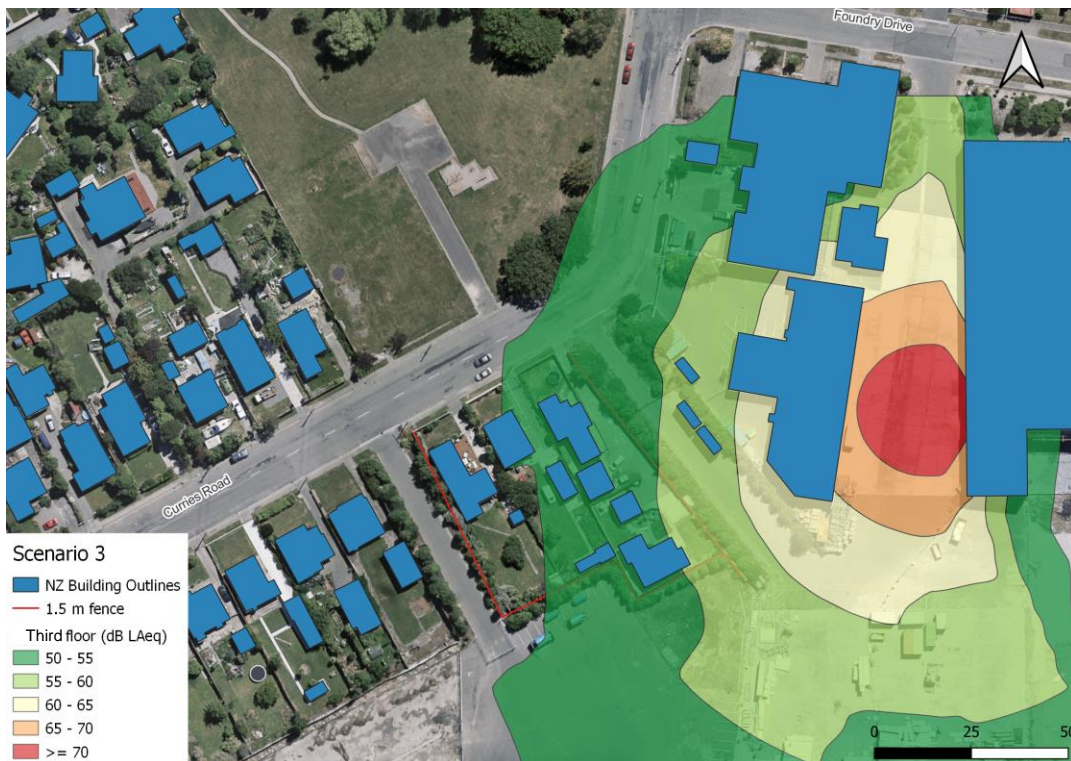


5.3 Scenario 3

5.3.1 Ground floor level Woolston

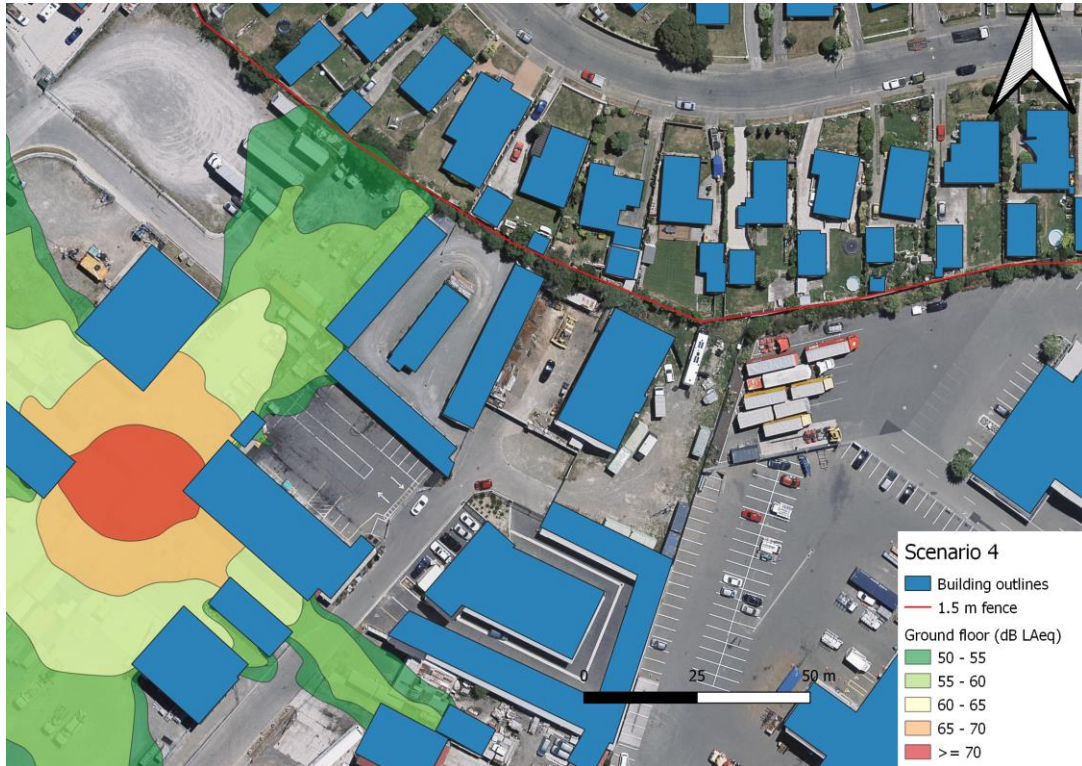


5.3.2 Third floor level Woolston

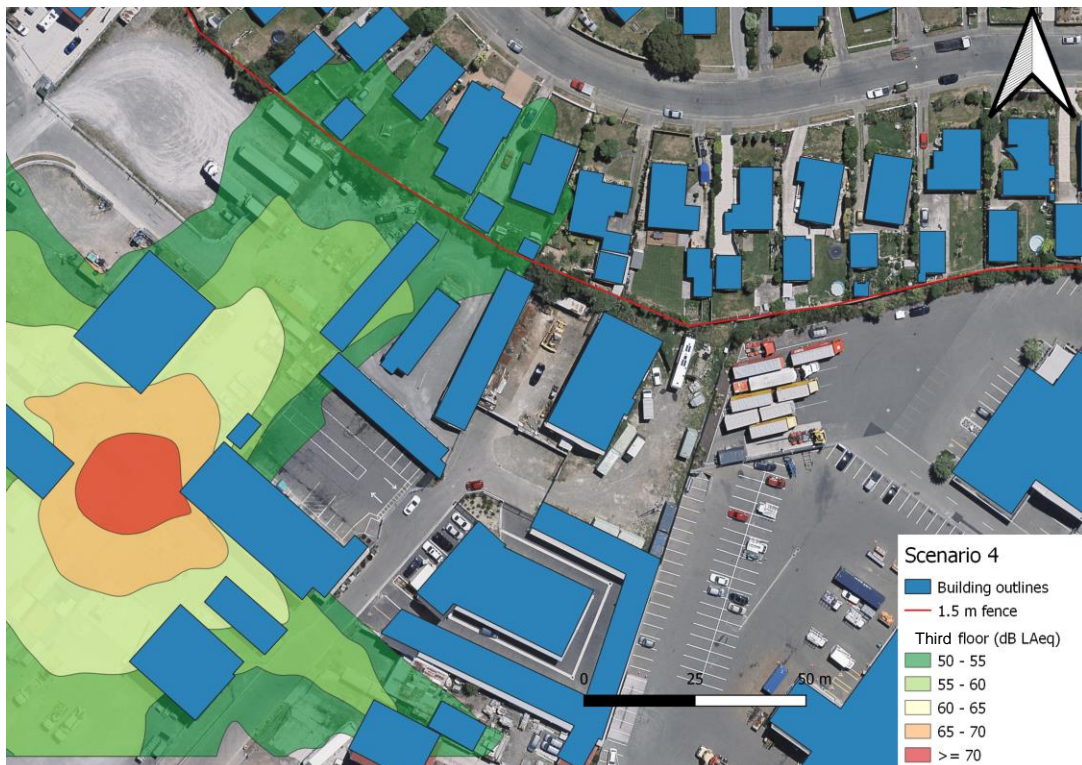


5.4 Scenario 4

5.4.1 Ground floor level Hornby Hei Hei



5.4.2 Third floor level Hornby Hei Hei



5.5 Scenario 5

5.5.1 Ground floor level Wainoni

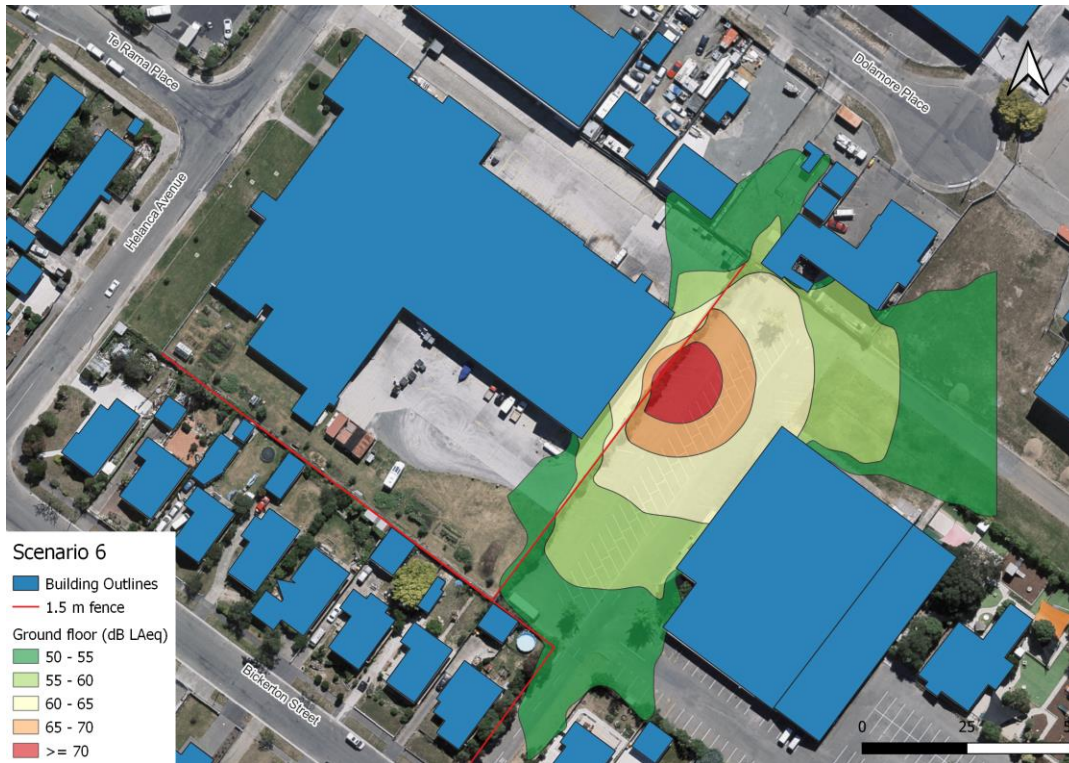


5.5.2 Third floor level Wainoni

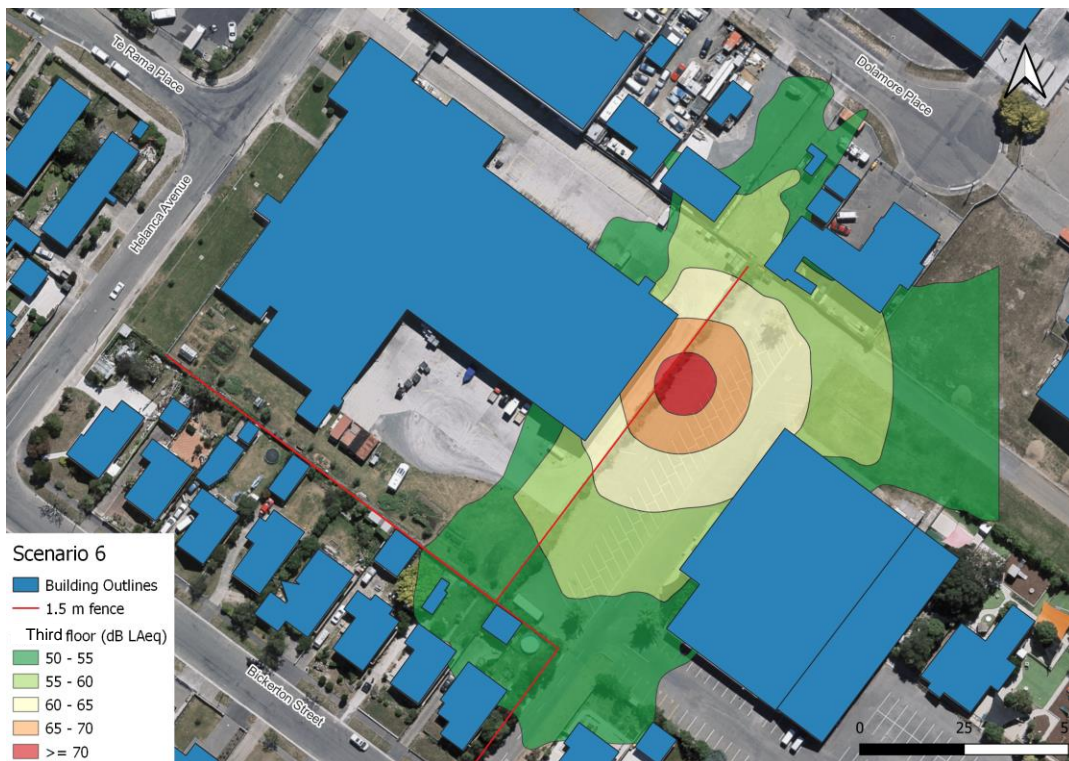


5.6 Scenario 6

5.6.1 Ground floor level Wainoni

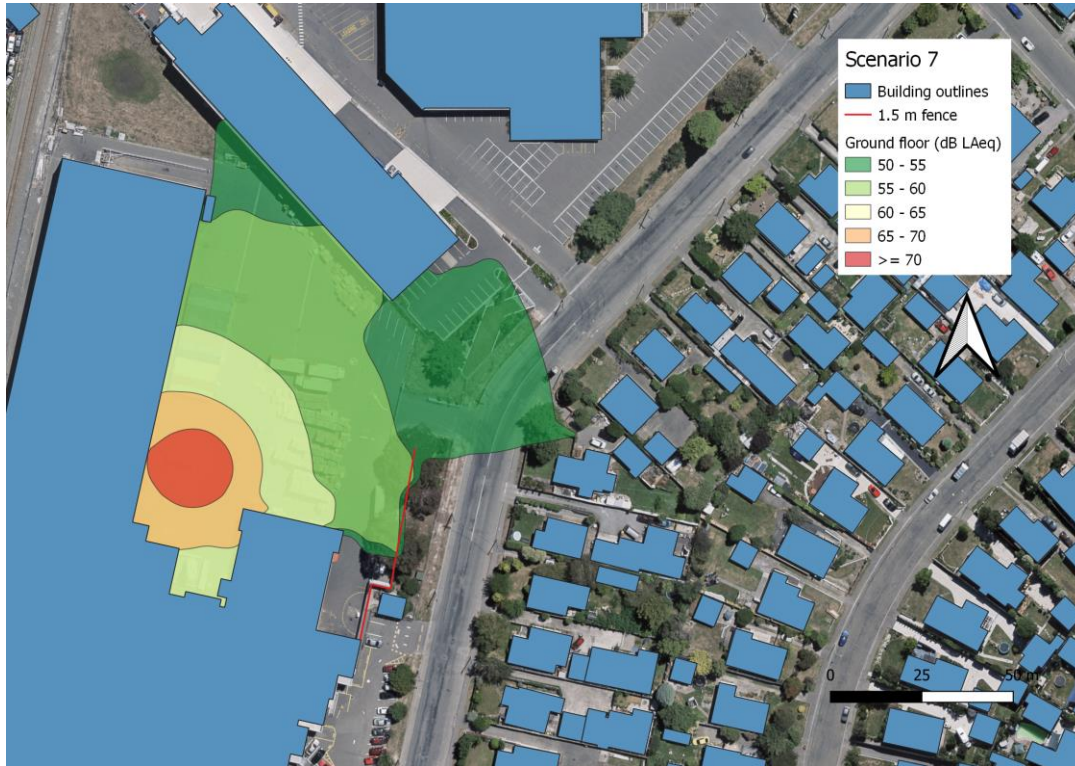


5.6.2 Third floor level Wainoni

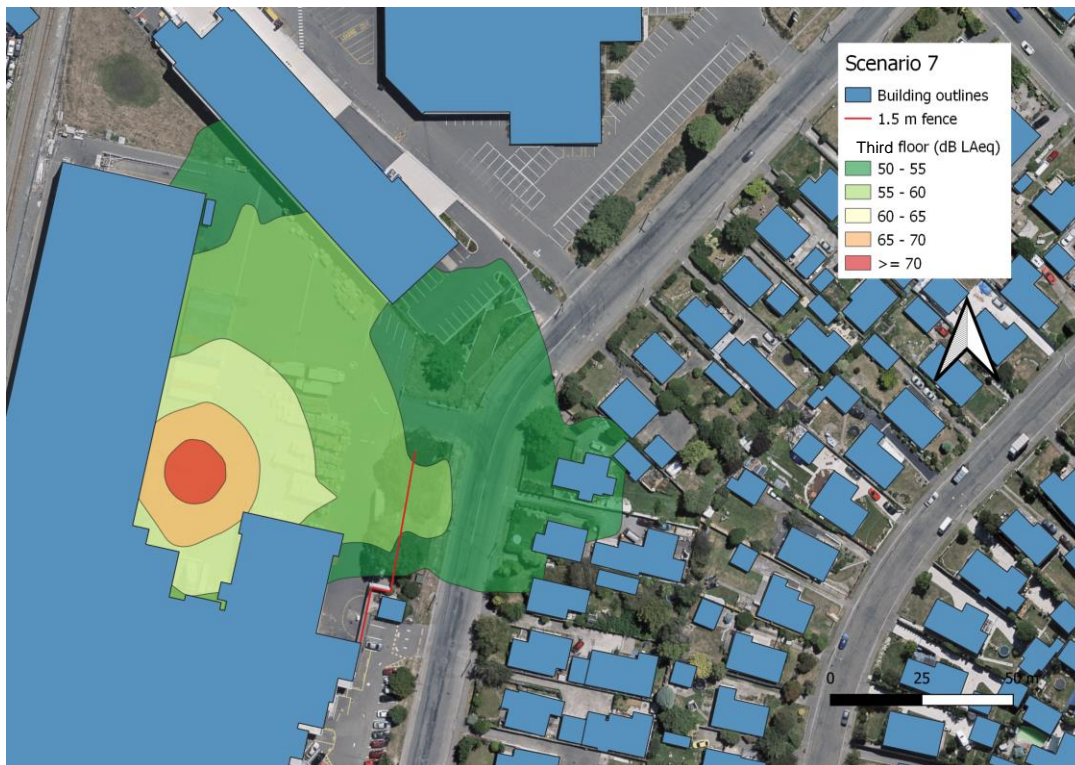


5.7 Scenario 7

5.7.1 Ground floor level Hornby Central

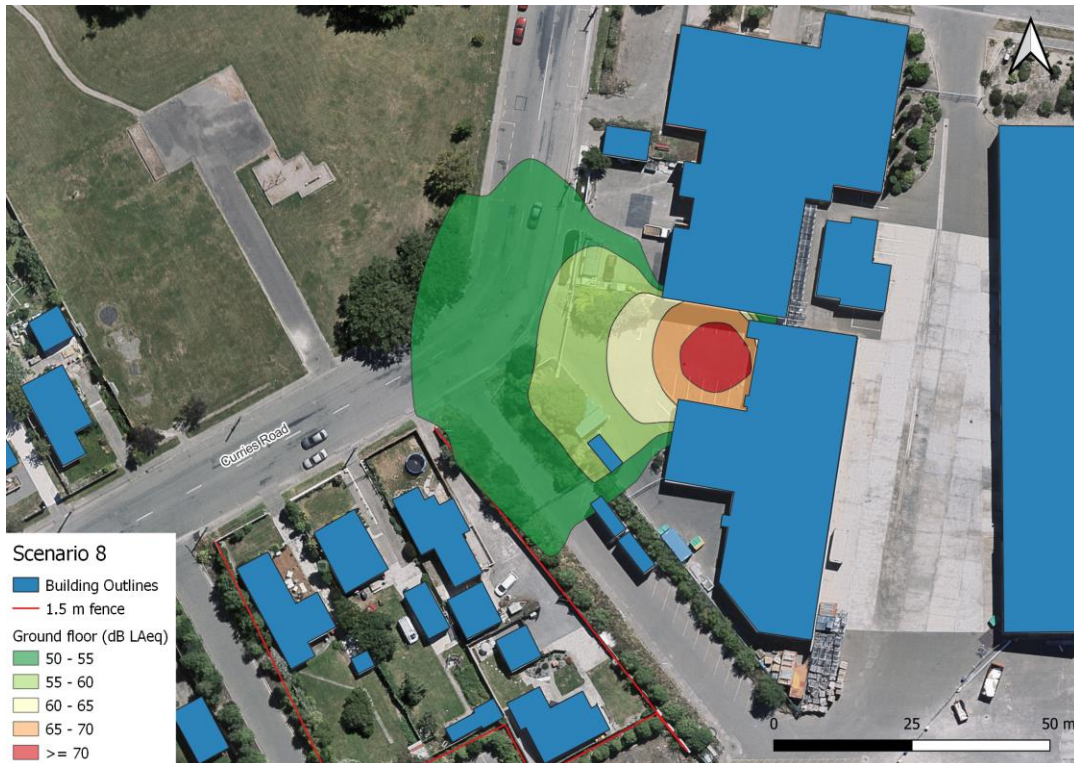


5.7.2 Third floor level Hornby Central

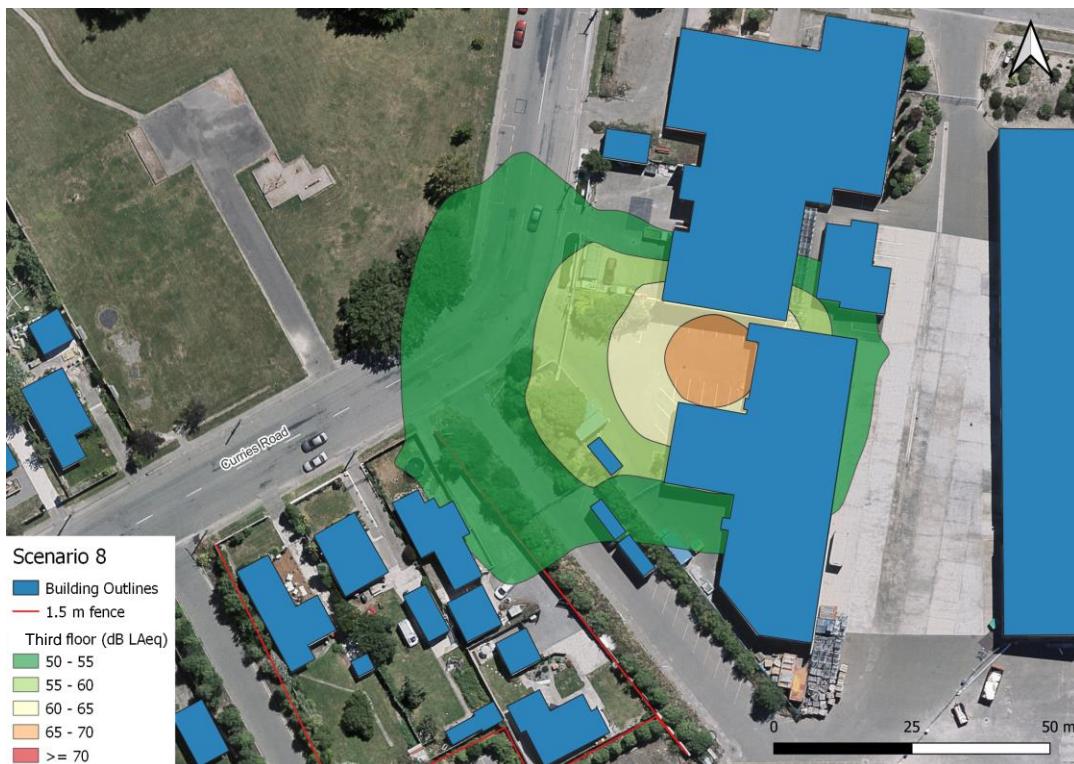


5.8 Scenario 8

5.8.1 Ground floor level Woolson



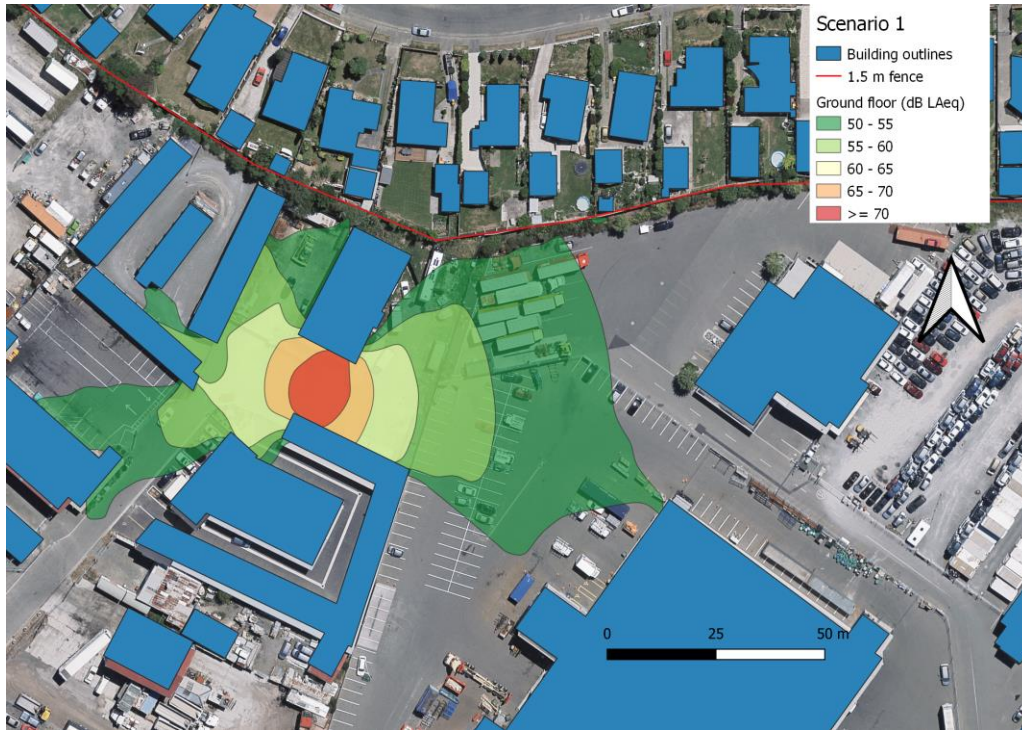
5.8.2 Third floor level Woolston



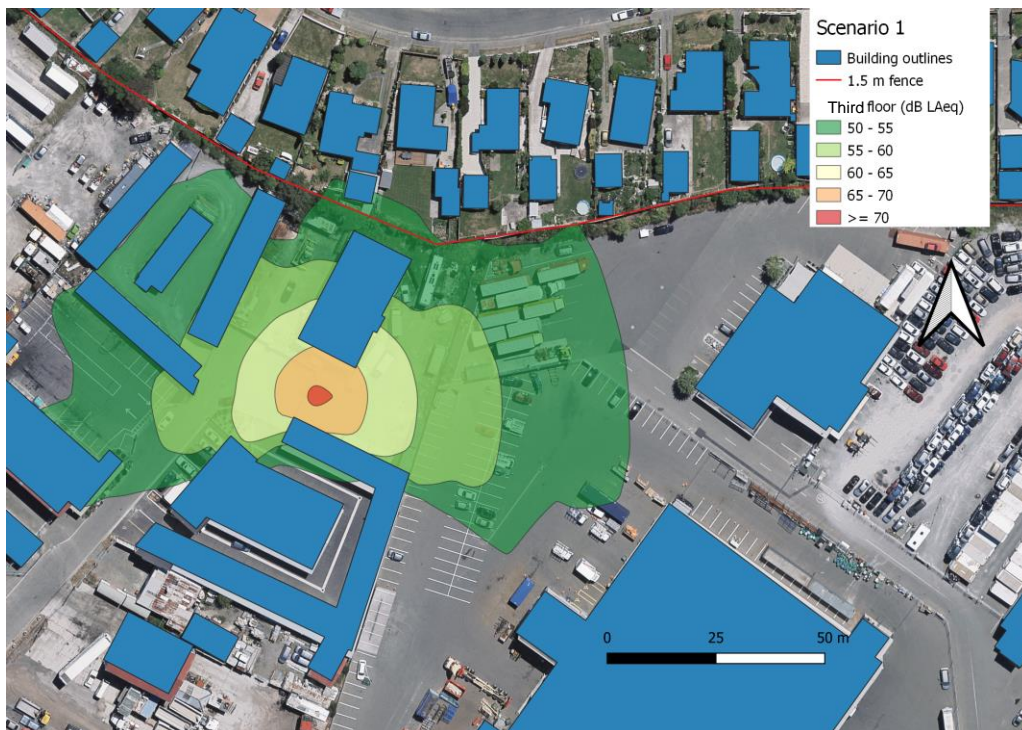
6.0 APPENDIX B – SITUATION 2

6.1 Scenario 1

6.1.1 Ground floor level Hornby Hei Hei



6.1.2 Third floor level Hornby Hei Hei

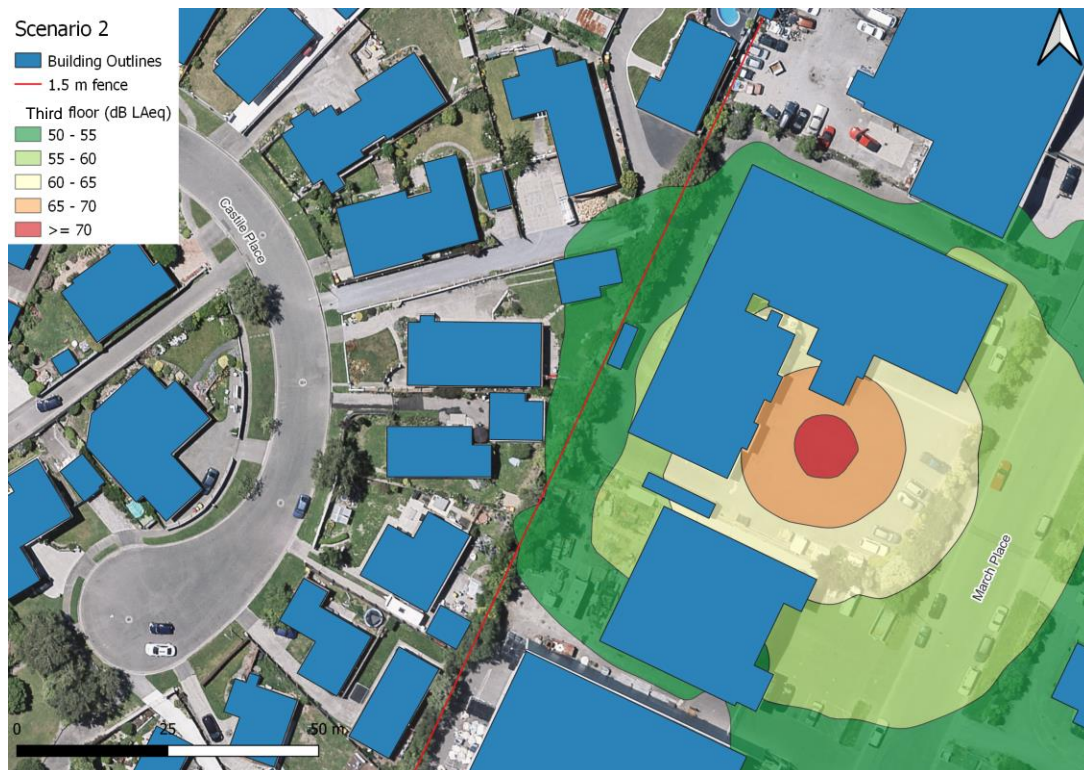


6.2 Scenario 2

6.2.1 Ground floor level Belfast

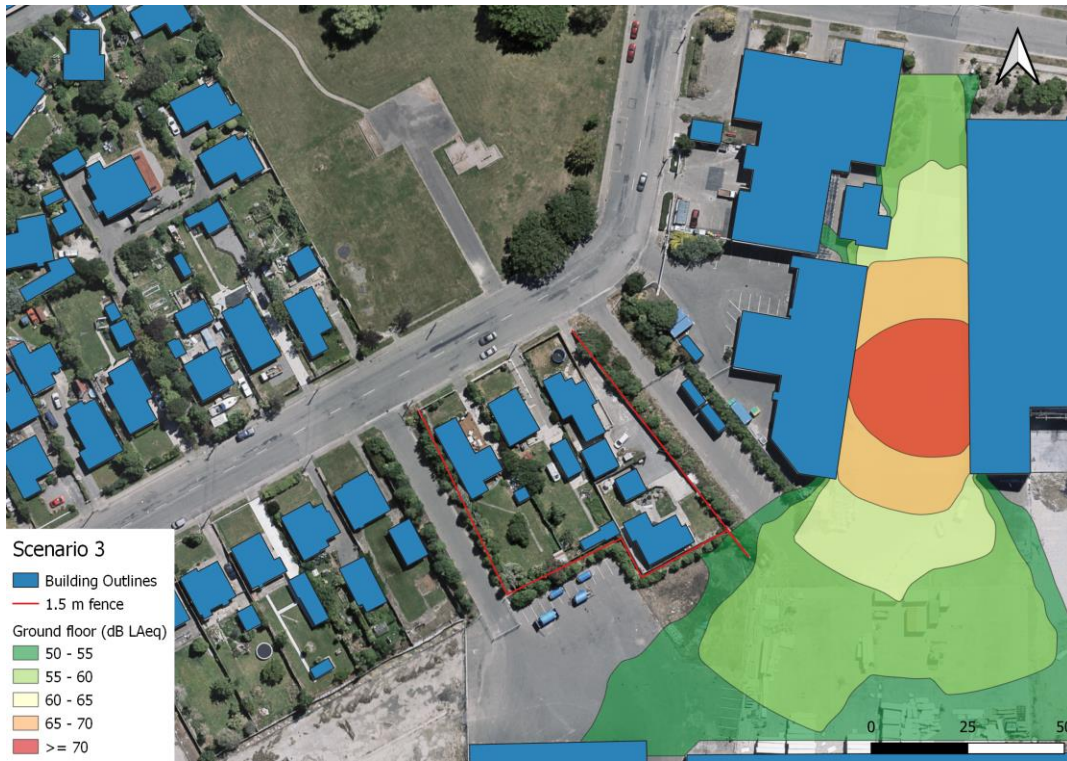


6.2.2 Third floor level Belfast

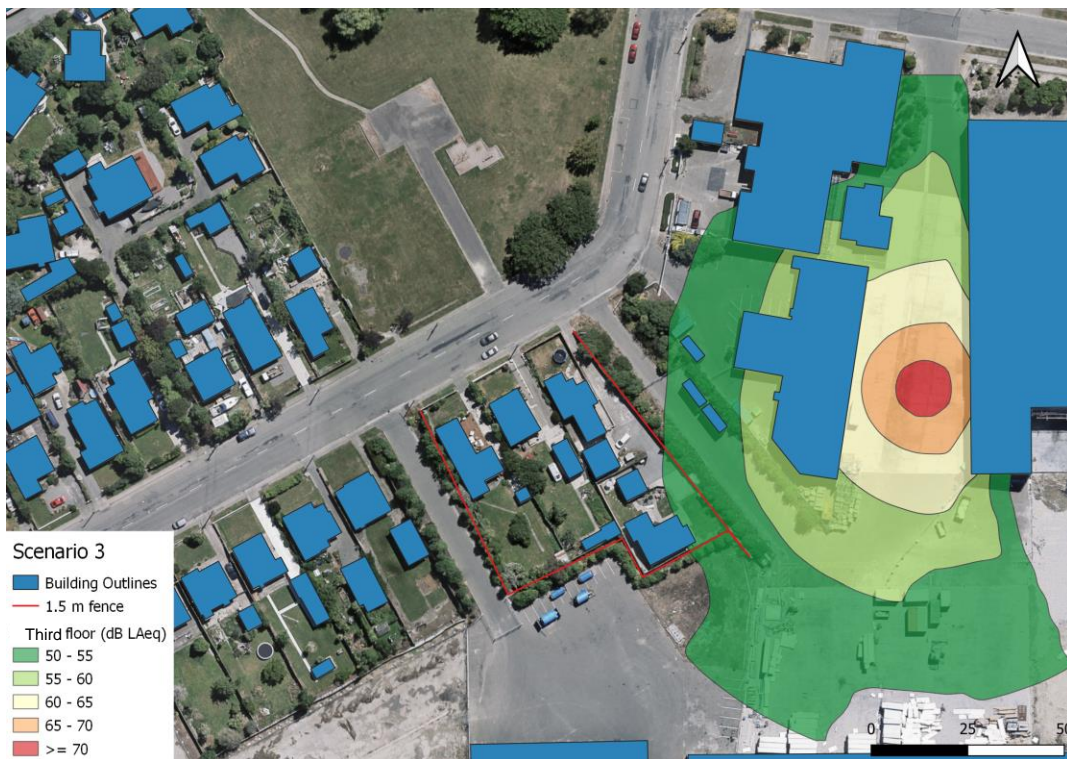


6.3 Scenario 3

6.3.1 Ground floor level Woolston

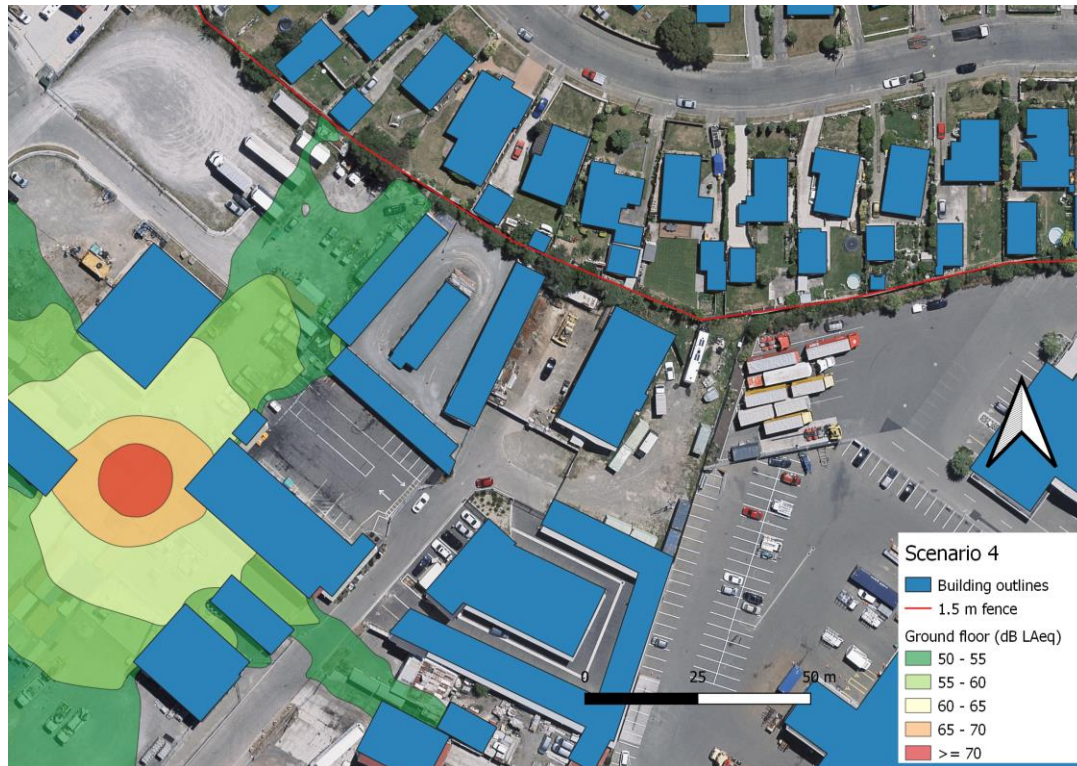


6.3.2 Third floor level Woolston

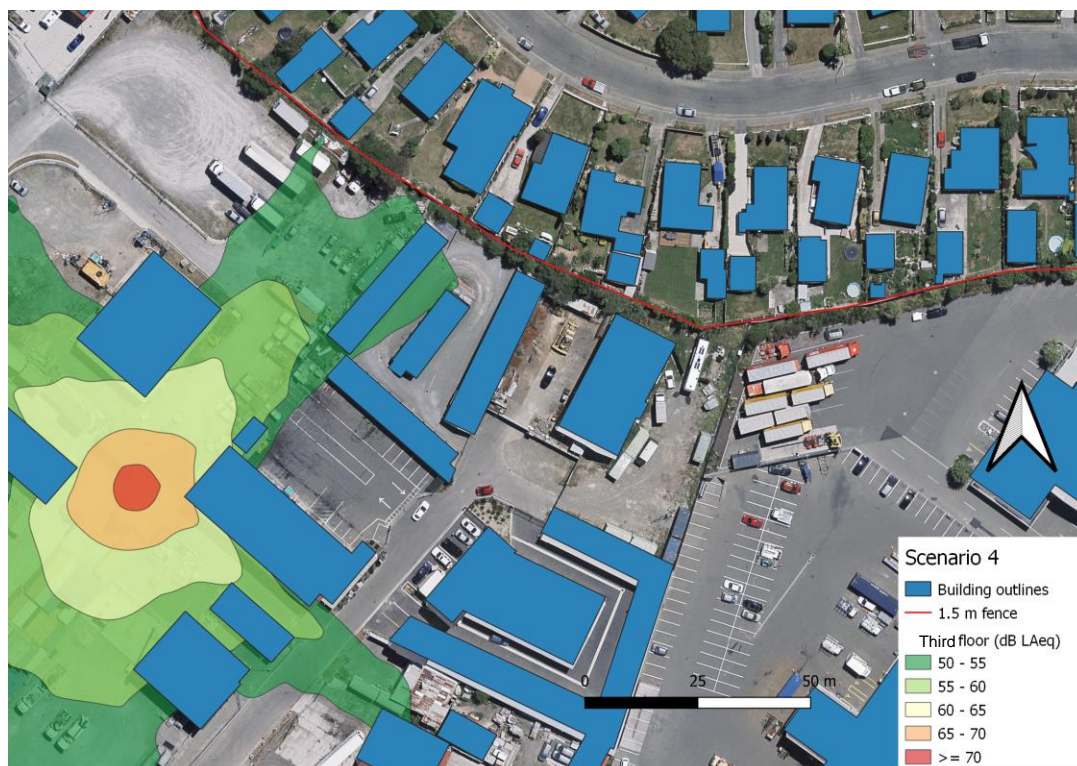


6.4 Scenario 4

6.4.1 Ground floor level Hornby Hei Hei



6.4.2 Third floor level Hornby Hei Hei



6.5 Scenario 5

6.5.1 Ground floor level Wainoni

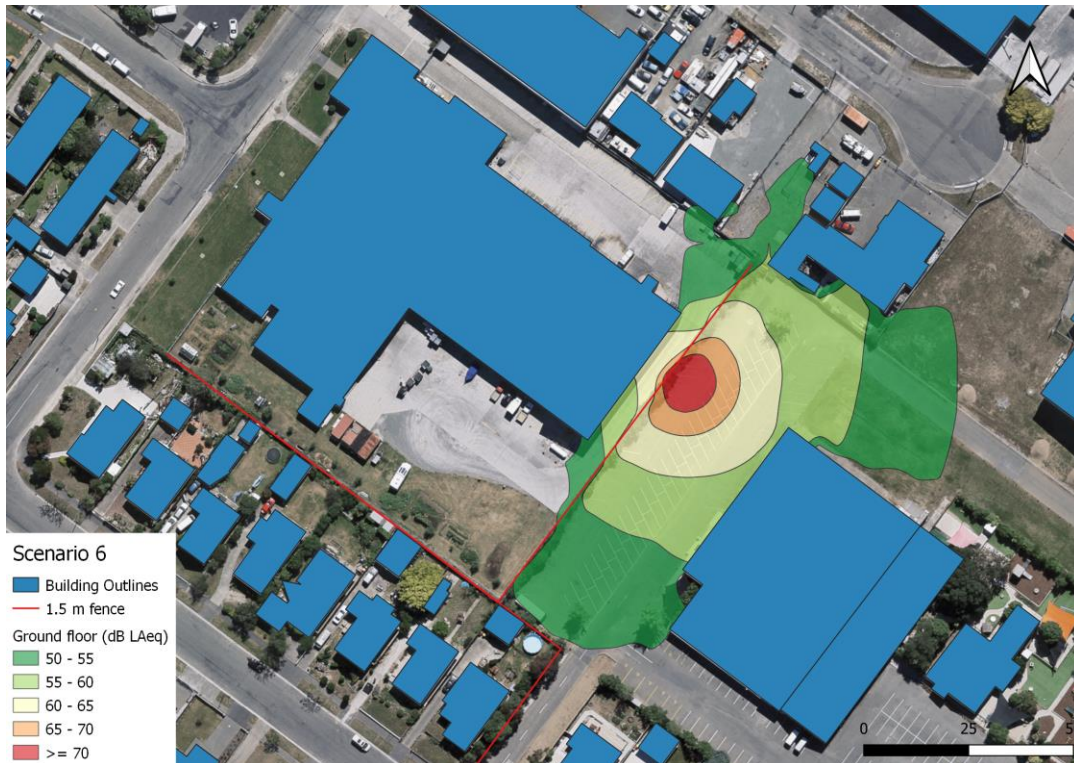


6.5.2 Third floor level Wainoni

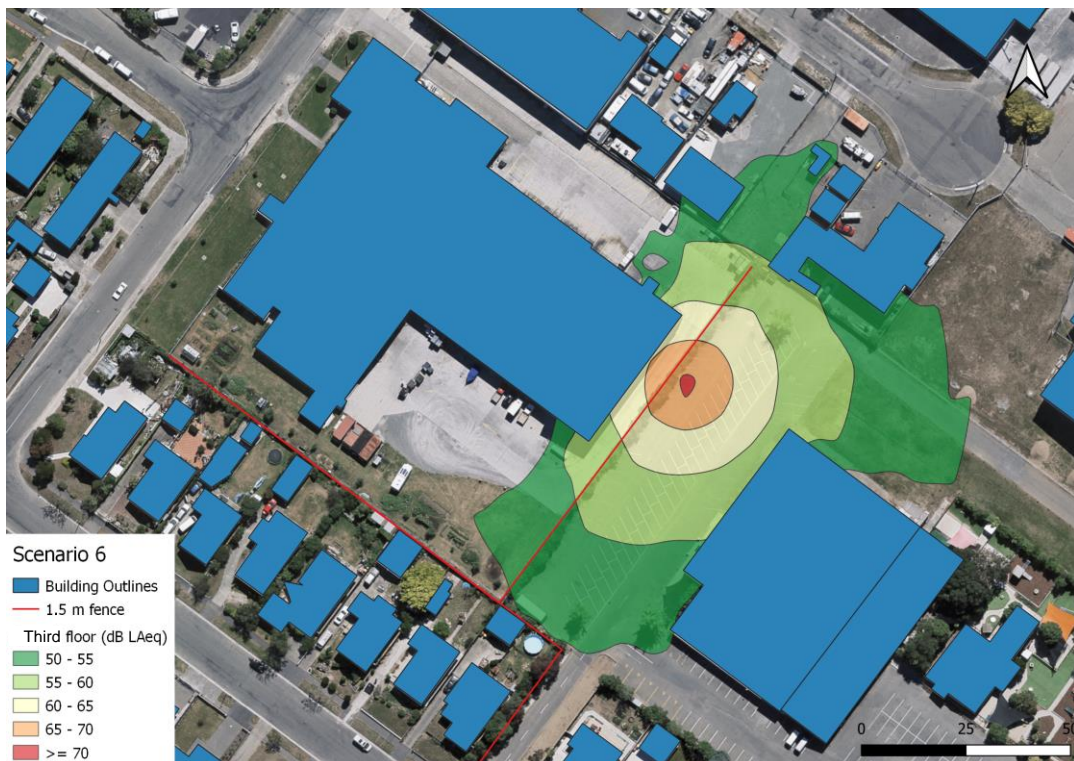


6.6 Scenario 6

6.6.1 Ground floor level Wainoni

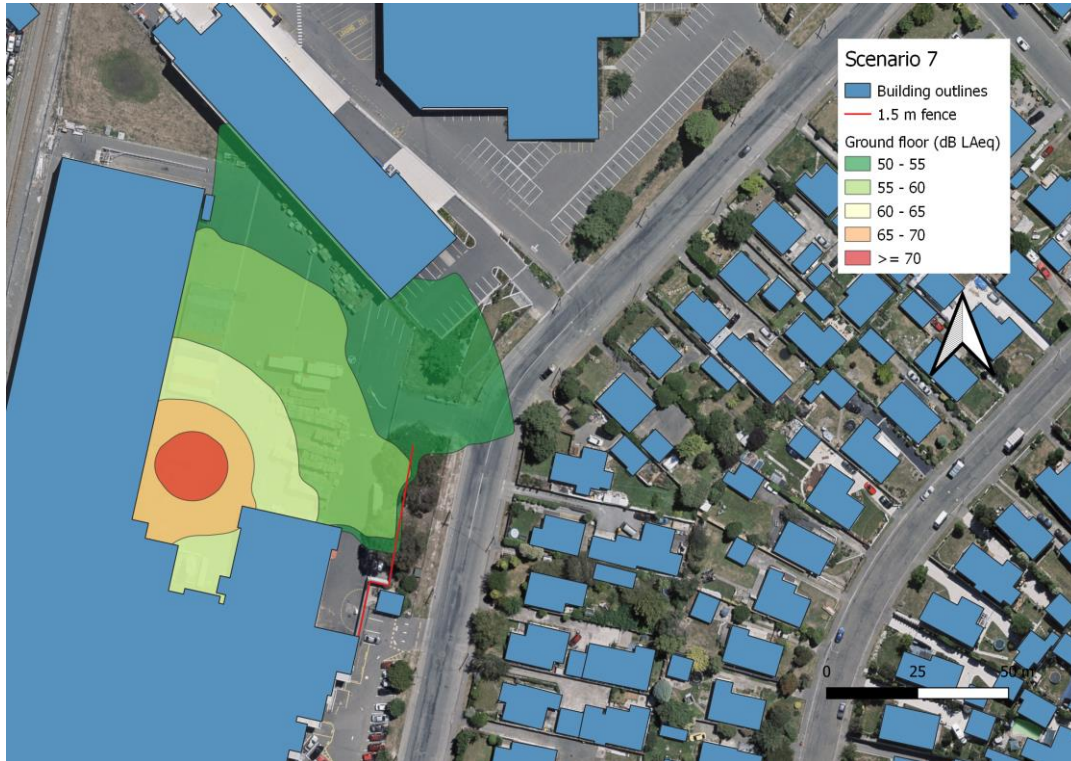


6.6.2 Third floor level Wainoni

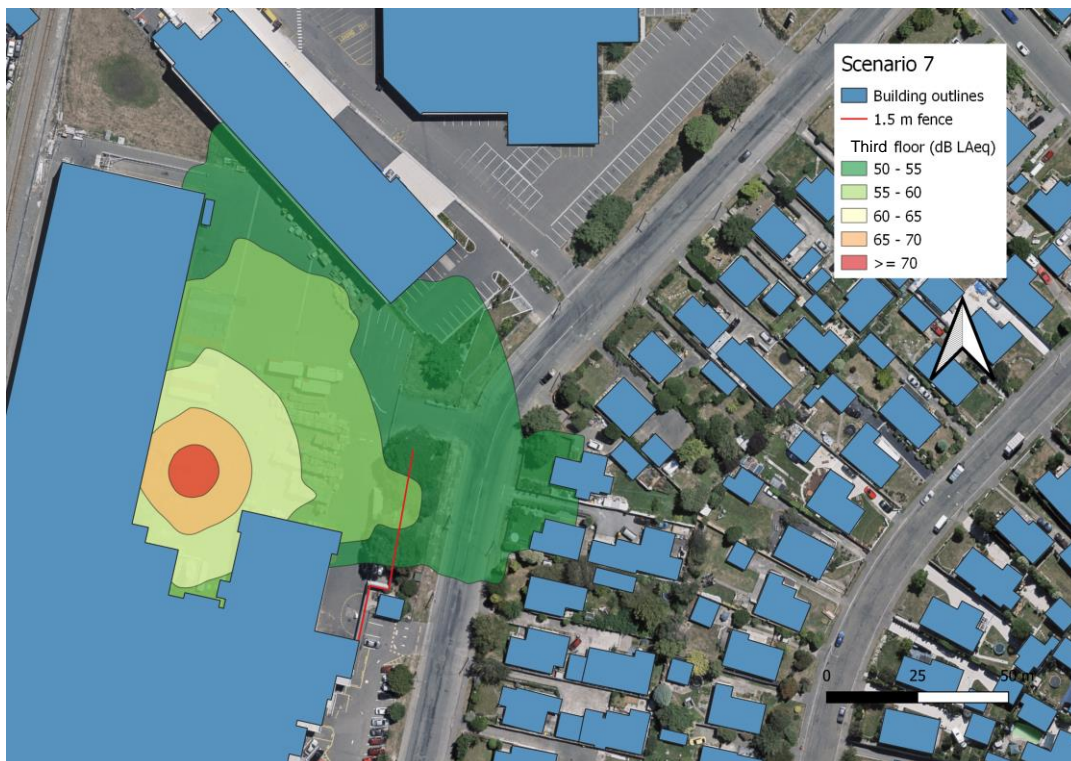


6.7 Scenario 7

6.7.1 Ground floor level Hornby Central

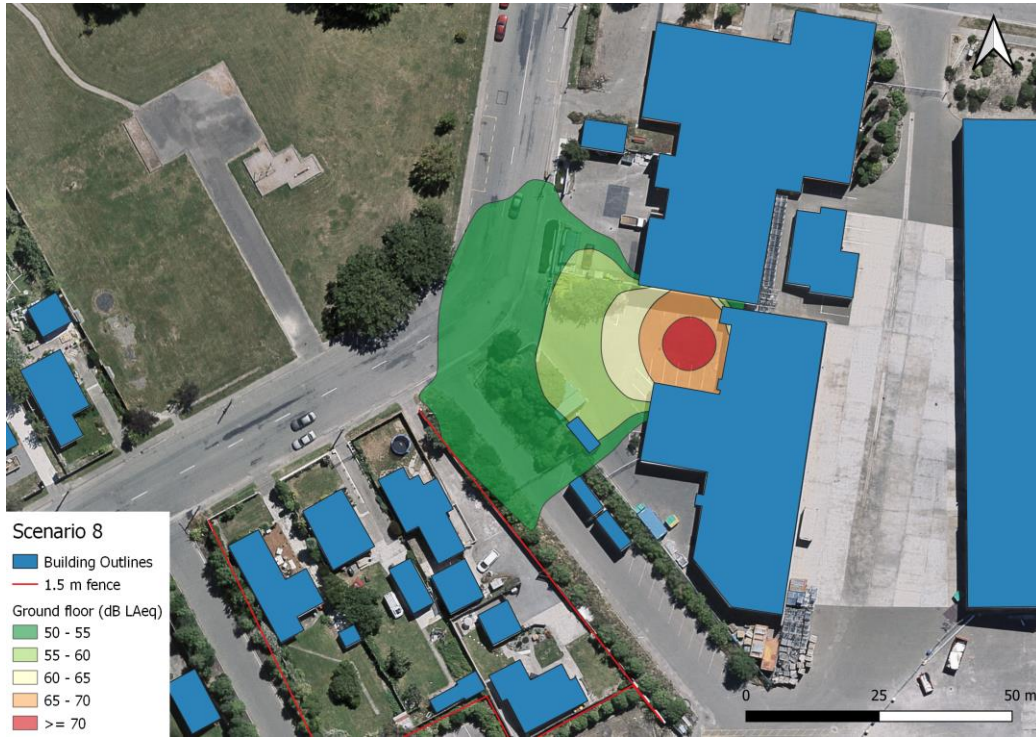


6.7.2 Third floor level Hornby Central



6.8 Scenario 8

6.8.1 Ground floor level Woolson



6.8.2 Third floor level Woolston

