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APPENDIX A

Construction Noise and Vibration Assessment – Marshall Day Acoustics

MARSHALL DAY Acoustics

RYMAN HEALTHCARE RETIREMENT VILLAGE KARORI
CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

Rp 002 R04 20200396 | 24 November 2020

MARSHALL DAY Acoustics

Project:	**RYMAN HEALTHCARE RETIREMENT VILLAGE KARORI**
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1.0 INTRODUCTION

Ryman Healthcare Ltd ('Ryman') proposes to construct and operate a comprehensive care retirement village ('Proposed Village') to be located at 26 Donald Street, Karori, Wellington (the 'Site'). Marshall Day Acoustics has been engaged by Mitchell Daysh Ltd, on behalf of Ryman, to prepare a Construction Noise and Vibration Assessment for this Project.

This assessment of construction noise and vibration is based on the indicative construction methodology for the Proposed Village set out in the following documents:

- Ryman document "Karori High Level Build Sequence" received 14/10/2020;
- Email from Ryman, containing some detail regarding construction equipment, received 14/10/2020;
- Ryman document "Terry Concept" received 5 November 2020;
- Email from Ryman, containing some further detail regarding construction equipment and proposed construction activities, received 5 November 2020;
- Ryman drawing package "*RCT FULL SET August 2020*".

2.0 SITE DESCRIPTION AND NEIGHBOURING PROPERTIES

2.1 Site Location

The Site is located in Karori, which is approximately 5 km from the Central Business District of Wellington. The area is predominantly residential in nature, with a range of commercial, community, recreational and educational activities servicing the suburb.

The Site is located close to a number of existing public facilities and schools - including Karori Mall, Karori Library, Karori Swimming Pool, Karori Normal School, Samuel Marsden Collegiate School and Ben Burn Park.

2.2 Closest Potentially Affected Receivers

The Site is surrounded by residential properties and activities that may be considered as noise sensitive. The closest and therefore potentially affected for limited durations during the construction period include:

- 21 to 45 Donald Street (37 Donald Street is an Early Childhood Education Centre);
- Karori Normal School on Donald Street;
- 23 to 51 Campbell Street (25 and 29 Campbell Street are Early Childhood Education Centres);
- 22 Donald St (Karori Swimming Pool);
- Even numbers 6 to 26 Scapa Terrace; and
- 221A and 221B Karori Road.

The closest receiver distances to the site boundary vary from 1 metre to 12 metres. Distances to actual working areas are still to be confirmed as part of the final construction methodology.

Properties located at greater distances from the Proposed Village may also be subject to noise and vibration from construction activities. However, due to their increased distance from the proposed activities and screening provided by the surrounding buildings, the noise and vibration effects will be less when compared with those properties identified above.

Figure B1 of Appendix B presents an aerial view of the subject site and the closest sites potentially affected by noise and vibration from construction activities.

3.0 PERFORMANCE STANDARDS

3.1 Construction Noise

The Wellington City Council District Plan requires that noise from construction activities be assessed in accordance with New Zealand Standard NZS 6803:1999 *'Acoustics-Construction Noise'*.

At this stage, a complete construction methodology is not available. However, we understand the duration of the construction period will be longer than 20 weeks. Therefore, the applicable construction noise limits are the "long term duration" limits of NZS 6803:1999, which are the most stringent in this Standard. These are reproduced in Table 1 overleaf.

The limits apply at 1 metre from the most exposed façade of all occupied dwellings and, during daytime, other buildings (e.g. the school buildings and the pool).

Table 1: Recommended upper limits for construction noise received in residential zones *(from New Zealand Standard NZS 6803: 1999 "Acoustics - Construction Noise" Table 2)*

Time of week	Time of period	Duration of work Long-term duration (dBA)	
		L_{eq}	L_{max}
Weekdays	0630-0730	55	75
	0730-1800	70	85
	1800-2000	65	80
	2000-0630	45	75
Saturdays	0630-0730	45	75
	0730-1800	70	85
	1800-2000	45	75
	2000-0630	45	75
Sundays and Public Holidays	0630-0730	45	75
	0730-1800	55	85
	1800-2000	45	75
	2000-0630	45	75

At this stage, the timing of construction activities has not been determined. It should be noted that the noise limits for the times identified by the shaded areas of Table 1 may mean that no noisy external construction activity could take place at those times.

As the buildings are completed, low noise activities, such as painting and plastering can be carried out indoors during those time periods with more stringent noise limits (i.e. early morning and night-time).

Given the spread-out nature of the site and the proposed staging of the construction works, any one receiver, or group of receivers, would be exposed to high noise activities for only limited times (e.g. a few days or weeks) over the entire construction period. Once the building fitout stage is reached, works would occur inside and be significantly quieter than any outside works.

3.2 Construction Vibration

The Wellington City District Plan does not address vibration resulting from construction activities. However, guidance can be found in DIN 4150-3:2016 *'Vibrations in buildings – Part 3: Effects on structures'*. This standard is used widely in New Zealand to assess the potential for vibration to cause damage to buildings. For construction vibration, the relevant DIN 4150-3:2016 criteria for this Project are both the 'Long-term' and 'Short-term' vibration criteria. The relevant criteria are shown in Table 2 below.

Table 2: Vibration Units to Avoid Building Damage *(from DIN 4150-3: 2016 Tables 1 and 4)*

Building Type	Short-term vibration					Long -term vibration	
	PPV (all directions) at the foundation at:			PPV (horizontal plane) of highest floor (mm/s)	PPV Floor slabs, (vertical) (mm/s)	Topmost floor, horizontal direction	Floor slab, vertical direction
	1-10Hz (mm/s)	10-50 Hz (mm/s)	50-100 Hz (mm/s)			All frequencies	
Residential, schools	5	5-15	15-20	15	20	10	10
Commercial or Industrial Buildings	20	20-40	40-50	40	20	5	10

Note, people may be able to 'feel' vibration at levels that are lower than would cause cosmetic and structural damage to buildings. During any consultation, this will be conveyed to concerned residents and building occupants.

4.0 CONSTRUCTION ASSESSMENT

We have predicted noise (Section 4.2) and vibration (Section 4.3) levels for various items of equipment likely to be used for the construction phase of this project. Additionally, we have provided a high-level assessment of the noisiest activity for various stages. This assessment is based on the following understandings:

- For the vast majority of construction works, compliance with occasional marginal exceedances of the 70 dB L_{Aeq} noise limit can be achieved.
- There will likely be some residual activities that generate noise levels above the limit for a limited duration (e.g. concrete cutting, piling in close proximity to the boundary). The noise effects from these activities need to be mitigated as far as practicable, and managed through communication with affected parties. The mitigation and management should be set out in a Construction Noise and Vibration Management Plan (CNVMP) (refer Section 5.0).
- A temporary noise barrier (minimum height 2.4 metres) should be installed to extend around the site perimeter, with a minimal number of openings to allow for site access. This noise barrier has been assumed in our assessment. We note that the noise barrier would be less effective for some houses, and for some construction activities, than for others. This is due to site geometry, as well as some houses being 2-storey.
- Where high noise equipment is used close to a sensitive boundary or where receivers are not easily shielded, localised barriers should be used where they would be effective and practicable. This is discussed further in this report in Section 5.1.
- A CNVMP should be prepared and implemented throughout the construction period. This will include communication procedures which will be the most important tool for managing construction noise and vibration effects.

4.1 Indicative Construction Method

As noted, at this stage, a complete construction methodology is not available. We recognise that the methodology will be finalised with the contractors closer to the time of construction. At this stage we understand from Ryman:

- Site preparation earthworks will be minimal.
- Foundations for Buildings B02 to B07 will be constructed with poured concrete slab foundations.
- Any required piling will be bored piling, which is the piling method that generates the lowest noise and vibration. Piling will be required for much of the new sections of Buildings B01A and B01B, as well as for the floor slabs under the existing Tennant Block (part of the proposed Building B01A).
- Additional bored piling is proposed for a stormwater detention tank, to be located between Buildings B03 and B04, adjacent to Scapa Terrace.
- The main noise source for works on the existing Allen Ward Hall (part of the proposed Building B01A) will be saw cutting of a small number of the exterior wall panels.

4.2 Noise

4.2.1 Construction Plant

Noise data for the indicative construction plant have been sourced from BS 5228-1:2009 '*Code of practice for noise and vibration control on construction and open sites Part 1: Noise*', and based on measurements of similar equipment, carried out by us.

Table 3 sets out predicted noise levels from the indicative construction equipment at relevant distances (generally without any mitigation) and also the distance at which compliance with the daytime noise limit of 70 dB L_{Aeq} can be achieved without mitigation (unless stated otherwise). We recommend that Table 3 is used, and updated at the time of on-site construction activities, to determine noise levels received at neighbouring buildings. This will inform what measures may need to be implemented to mitigate and manage potential effects and to ensure general compliance with the noise limits of NZS 6803:1999.

Table 3: Indicative noise levels at 1m from a building facade with no mitigation

Equipment	Sound Power (dB L_{WA})	Façade Noise Level (dB L_{Aeq})*				Setback distance (m) to comply with 70 dB L_{Aeq}
		5m	10m	15m	30m	
Concrete saw (large)	114	95	89	85	79	70
Excavator loading truck	113	94	88	84	78	65
Bored piling rig	111	92	86	82	76	55
Plate compactor	108	89	83	80	73	40
Grinder (hand tools)	108	89	83	79	73	40
Loader	107	88	82	78	72	40
Excavator (40T)	107	88	82	78	72	40
Crawler Crane (280T) operating	106	87	81	78	72	35
Excavator (30T)	105	86	80	76	70	30
Tower Crane	104	85	79	75	69	30
Excavator (20T)	103	84	78	74	68	25
Concrete truck and pump	103	84	78	74	68	25
Static or vibratory roller	103	84	78	74	68	25
Excavator (5T)	102	83	77	73	67	25
Concrete vibrator	97	78	72	68	62	15
Tower Crane (electric)	95	76	70	66	60	10
Generator (150kVA)	93	74	68	64	59	10
Compressor	93	74	68	64	59	10
Truck Idling	91	72	66	62	56	10

*Shaded cells show an exceedance of the NZS 6803:1999 daytime noise limit of 70 dB L_{Aeq}.

An effective construction noise barrier, such as the 2.4m barrier recommended by us, around the perimeter of the Site will reduce the compliance setback distance in Table 3 by up to 2/3 and reduce noise levels by up to 8 to 10 decibels.

4.2.2 Computer Noise Modelling

We have predicted construction noise levels for selected high noise activities using sound modelling software SoundPLAN to account for the terrain, and the 2.4 metre high noise barrier around the perimeter of the Site.

We consider the following construction scenarios to be the noisiest likely to occur. Consequently these are the scenarios we have modelled. These are:

- Slab preparation;
- Slab construction;
- Area 1 stormwater tank piling;
- Building B01A and B01B piling;
- Tennant Block piling;
- Allen Ward Hall concrete cutting;

All other activities will be similar to common construction activities that would occur on any larger scale development site, such as the use of concrete trucks, excavators and cranes.

When predicting noise from construction activities, there is always a level of uncertainty. There are numerous variables and factors affecting the accuracy of the noise predicted. These factors include the variations in the specific models and individual items of equipment, the exact location of each item, the operator idiosyncrasies and the exact location of the various receivers.

The predicted noise levels are based on a conservative worst-case scenario of the noisiest equipment being operated 100% of the time and only the 2.4m perimeter fencing as mitigation.

Given the work site space constraints, close proximity of receivers and sequencing, any noise events that exceed the noise limits would almost always be dominated by one noise source (e.g. concrete cutting or the closest piling rig). This would also be the case when considering concurrent use of equipment on the Site. While the ambient noise level may increase due to concurrent operation of equipment (e.g. more than one piling rig), the resulting cumulative noise level during any exceedance would generally increase by less than 1 – 2 decibels. This is an indiscernible change in noise level.

The figures in Appendix C show the predicted noise levels. These provide an insight into the potential noise levels at the nearby receivers from works at potential worst-case locations. As noted above, based on our experience of similar projects, any one receiver would be exposed to high noise activities for only a fraction (i.e. a matter of days or at most weeks) of the entire construction period. Groups of receivers will receive higher construction noise levels during construction activities closest to them. Noise levels will be lower during construction activities at greater separation distances.

Mitigation of construction noise is discussed in Section 5.1 of this report.

4.2.3 Predicted Construction Noise Levels – Site preparation

The Site will require some preparation in terms of flattening, compaction and preparation of surfaces for slab construction. Generally, this phase involves the use of trucks, excavators, and vibratory rollers to compact the ground. Most of the Site will be somewhat affected by this activity, and we have predicted noise levels from equipment across the Site.

We have calculated that the noise from these construction activities will marginally exceed the 70 dB L_{Aeq} noise limit (7:30am – 6pm Monday to Saturday) of NZS 6803:1999 at a small number of dwellings in Scapa Terrace. Depending on the location of the various activities on the Site, and the location of the dwellings, this exceedance is predicted to be less than 2 dB, which is an unnoticeable difference compared to the compliance limit and will occur only intermittently when works are close to the relevant boundary.

4.2.4 Predicted Construction Noise Levels – Slab Construction

The main anticipated noisy equipment for slab construction will include concrete trucks and pumps, concrete vibrators, trucks and plate compactors. Construction would extend across the entire Site, with equipment moving around the Site as construction progresses. Where more than one slab is constructed at a time, these slab areas will normally be separated to ensure safe site operations and would not normally affect the same receivers.

We have calculated that the noise from these construction activities will generally comply with the 70 dB L_{Aeq} noise limit (7:30am – 6pm Monday to Saturday) of NZS 6803:1999. Where several items of equipment operate close to a boundary, noise levels may at limited times reach levels of 71 or 72 dB L_{Aeq}, which would not be a noticeable difference for any receivers, compared with the compliance limit.

4.2.5 Predicted Construction Noise Levels – Area 1 Stormwater Detention Tank Piling

We have assumed that one piling rig will be used for this activity.

We have calculated that marginal exceedances of up to 2 decibels above the 70 dB L_{Aeq} limit (7:30am – 6pm Monday to Saturday) of NZS 6803:1999 will occur at one dwelling: 24 Scapa Terrace.

The main noise source of a piling rig is generally the diesel engine, which will be located slightly further from the boundary and will face away from the dwellings. The dwelling at 24 Scapa Terrace is double storey and will therefore not receive effective shielding at the upper floor, resulting in the predicted marginal exceedance. All other dwellings in the area appear to be single storey and will receive effective shielding from the 2.4m barrier.

4.2.6 Predicted Construction Noise Levels – Buildings B01A and B01B Piling

We have assumed that one piling rig will move along the Site to undertake the piling. In the event that two piling rigs are used, these should have a distance of at least 50 metres from each other, so that the overall noise level is not materially affected at each receiver position.

During these piling operations, exceedances of the 70 dB L_{Aeq} limit (7:30am – 6pm Monday to Saturday) of NZS 6803:1999 are predicted to occur at two buildings:

- Karori Pool by up to 7 dB, and
- Karori Normal School by up to 6 dB.

Additional mitigation could be considered for the school area, such as the installation of higher barriers or stacked containers, for the limited time that piling occurs in close proximity to the buildings. Alternatively, it may be possible to schedule the piling works to be undertaken during school holidays, when the school is not occupied, or after 3pm on school days.

The pool is unlikely to be noise sensitive, and we do not consider that additional mitigation is required.

4.2.7 Predicted Construction Noise Levels – Tennant Block Piling

We have assumed that one piling rig will be used for these works.

We predict only marginal exceedances of up to 1 decibel above the 70 dB L_{Aeq} limit (7:30am – 6pm Monday to Saturday) of NZS 6803:1999 at Karori Normal School. Such exceedance would not be noticeable or audible compared to the compliance limit, and therefore is not material. Management of construction noise received at Karori Normal School will be included in the CNVMP, and is discussed in Section 5.1 below.

4.2.8 Predicted Construction Noise Levels – Allen Ward Hall

The noisiest activity for this building is anticipated to be the use of concrete saws for the removal of a small number of external façade panels. Much of the external façade concrete cutting would be elevated in relation to the site noise barrier fence. Therefore, the fence will provide no mitigation.

We have assumed that only one concrete saw is used for the deconstruction of the concrete panels.

During the external concrete cutting, we predict that the resulting noise will exceed the 70 dB L_{Aeq} limit (7:30am – 6pm Monday to Saturday) of NZS 6803:1999 at 10 buildings. The highest predicted noise levels at each building is:

- 27 Donald Street – 81 dB L_{Aeq}
- 29 and 31 Donald Street – 80 dB L_{Aeq}
- 25 Donald Street – 78 dB L_{Aeq}
- 23 and 33 Donald Street – 76 dB L_{Aeq}
- 35 and 37 Donald Street – 74 dB L_{Aeq}
- Karori School – 73 dB L_{Aeq}
- 21 Donald Street – 72 dB L_{Aeq}

The most affected dwellings are immediately opposite the works. No mitigation in terms of barriers is available. Alternative measures that could be investigated include the use of diamond wire cutters instead of concrete saws. These wire cutters have been measured by us to be between 5 and 15 decibels quieter than the saw. However, the contractor will have to determine if this is a practicable alternative in the circumstances.

These works will be of limited duration. We understand Ryman does not anticipate the façade panel works will occur for more than one week, with intermittent breaks when the loosened elements are taken off the building.

4.2.9 L_{max} Levels

The maximum noise level from construction operations cannot be reliably predicted as it depends on non-standardised sources such as an excavator operator putting down the bucket too hard, track squeal of a tracked excavator or the initial falling of fill into an empty truck bed. None of these sources are homogenous, and L_{max} levels can vary widely.

However, generally, L_{Amax} noise levels for construction activities are typically 10 to 15 dB above the L_{eq} value. Therefore, the 85 dB L_{Amax} noise limit is predicted to be complied with between 7:30am and 6:00pm hours, Monday to Saturday, at most assessment locations.

Mitigation of construction noise is discussed in Section 5.1 of this report.

4.3 Vibration

The majority of construction activities will not generate high levels of vibration at most assessment locations.

The use of vibrating rollers and excavators may produce levels of vibration which are perceptible to occupiers when operated close to that dwelling. However, in general, the levels are predicted to be compliant with the criteria set out in Table 2.

The bored piling proposed is the form of piling generating the lowest vibration levels and is not considered to be an activity causing any risk of building damage or even annoyance.

Table 4 presents conservative setback distances required to comply with the relevant vibration limits. These are sourced from databases or measurements that we have previously carried out for other projects, and include a 100% safety margin.

Table 4: Vibration set back distances

Vibration Source	Set back distances (m) to comply with Residential vibration limit 5mm/s PPV	Set back distances (m) to comply with Commercial vibration limit 10mm/s PPV
Bored piling	1	<1
Excavator	4	1
Vibratory roller	8	5

Dwellings at 33 and 33A Campbell Street are closer than 8 metres from the closest Proposed Village buildings. We therefore recommend that in close proximity to these dwellings either non-vibratory compaction is used (e.g. using rollers with the vibration function switched off), or that a building condition survey is undertaken prior to and following construction, to establish if any damage may have been caused by construction.

Mitigation and management of construction vibration is discussed in Section 5.2 of this report.

5.0 CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLAN

We recommend that a CNVMP is prepared by a suitably qualified person prior to works commencing on the Site. This CNVMP should be implemented throughout the construction period of the project to manage construction noise and vibration levels.

The overarching approach of the CNVMP should align with Section 16 of the Resource Management Act (RMA) which, in summary, states that an activity shall adopt the best practicable option to ensure that the emission of noise (and vibration) does not exceed a reasonable level.

The CNVMP should include (but not be limited to) details regarding:

- Community liaison;
- Mitigation measures (discussed in Sections 5.1 and 5.2 of this report);
- Noise monitoring. This would include:
  - Measurement of construction noise received at selected representative receiver locations. Noise measurements would provide the Contractor with information regarding construction methodology; identify any processes that are unnecessarily noisy; and provide confidence to potentially affected residents that their concerns are being addressed.
- Vibration monitoring. This would include:
  - Vibration measurements at the onset of activities most likely to cause vibration (e.g. operation of the vibrating roller) to confirm predictions;
  - Carrying out a pre-construction survey of the closest buildings, with photographic records, etc., for purposes of subsequent comparison, should claims arise regarding building damage due to vibration.

Note that vibration levels which may be subjectively classed as strongly perceptible and even disturbing may be quite safe in terms of building damage risk criteria. Consultation and communication with residents to convey this are of utmost importance.

- Contingency measures including, but not limited to, restricting the hours or days of some activities, review of construction methodology, mitigation measures and management strategies to ensure they represent the BPO; and
- Staff training.

5.1 Construction Noise Mitigation

We recommend that the following noise mitigation measures are considered in the development of a CNVMP for this project:

- Site perimeter noise barrier 2.4m high: as noted in Section 4.0, this barrier fence should extend around the site perimeter, with a minimal number of openings to allow for site access. To be effective, this barrier fence must be solid with no gaps between panels or planks, or between the fence and the ground. The fence material must be of a minimum mass of 12 kg/m^2. Such shielding may consist of 18 mm thick plywood or similar.

  To provide an effective noise barrier, this fence needs to block line-of-sight to the receiver. Consequently, its effectiveness will also depend to a large degree on the height of the noise source above the ground, the location of the noise source on the Site, and the location and height of the receiver.

- Temporary noise barriers: These barriers should be used where a construction noise limit is predicted to be exceeded, and where the barriers would noticeably reduce the construction noise level. They should be installed prior to works commencing and maintained throughout the works. Effective noise barriers typically reduce the received noise level by 5 to 10 decibels. Such barriers can include 25 mm thick plywood screens, mass loaded sheet vinyl (minimum of 8 kg/m^2) or other suitable material. Note that a barrier screen needs to interrupt the line of sight between the noise source and a receiver to be effective. The locations of various construction noise sources and barriers require careful selection. For instance, for some noise sources close to the ground (plate compactor, etc.), a correctly located small noise barrier close to the source has potential to reduce the noise from that source. Noise barriers are at their most effective when located close to either the noise source, or to the receiver.
- Communication and engagement with neighbours: the higher noise activities we have predicted are limited in duration and location. We recommend good engagement with potentially affected neighbours to understand sensitivities. This engagement should especially include discussion with the school, where higher noise activities may be able to be scheduled during holidays, for Saturdays or after school hours. Given the potential sensitivity of the school activities, effects on the school will need to be managed and mitigated through a comprehensive approach. We recommend including specific responses to the school in the CNVMP. This is because even with compliance with the noise limits of NZS 6803:1999, there is potential for learning activities to be interrupted without appropriate management.
- Loading of trucks: our experience has shown that loading any excavated material onto trucks can provide a significant source of noise, particularly with the first loads into an empty tray. Careful selection of the location of loader routes and loading points is important (away from noise sensitive receivers). Additionally, the material (particularly the first loads) should be carefully placed into the tray, rather than “dumped” from a height above the tray.

- Clearing the pile drill: For bored piling methods, avoid shaking the auger to remove spoil where practicable. Shaking the kelly bit connection can result in very loud banging that often results in noise complaints. If spoil does not fall off the auger easily, use tools to scrape the auger clean if necessary.
- Location of construction plant items when operating: some items of plant can be relatively noisy. When operational, these plant items should be located as far as practicable from dwellings.
- Maintenance of construction equipment to reduce noise resulting from the deterioration of equipment.
- Alternatives to the standard tonal reversing alarms of mobile equipment operating on the construction site should be investigated. Such alternatives include broadband (white noise) reversing alarms (at distance, sound from broadband alarms are subjectively less noticeable and less annoying when compared with tonal alarms), and/or flashing warning lights.

5.2 Vibration Mitigation and Management

We recommend that the following vibration mitigation measures are considered in the development of a CNVMP for this project:

- Approval should be sought from the owners of the closest properties to undertake a building condition survey at the following times:
  - Prior to construction commencing;
  - In response to a reasonable claim of damage from construction vibration
  - Post construction, to identify any damage from construction vibration.
- Operation of vibration-generating equipment as far as possible from dwellings (where practicable);
- Prioritise the use of static rollers over vibratory rollers, or switch off the vibration function within predicted safe setback distances (8 metres from a dwelling);
- Match the size of roller to the scale of the works (i.e. large enough to undertake the works efficiently, but avoiding oversized units);
- Match the vibration output to the scale of the works (i.e. combination of minimising the amplitude of the drum vibration and/or maximising the vibration frequency of operation);
- Manage construction activities so that several vibration-generating activities do not occur simultaneously;
- Manage operator behaviour, e.g. no hard setting down of the excavator bucket to loosen material, no dropping concrete panels from height;
- If monitoring near any potentially affected properties confirms an exceedance of the building damage criteria, then the works should stop when reasonably practicable, and a condition survey of those dwellings carried out. If no new damage has been found, then the vibration limit at that receiver can be increased. If there has been damage found and that it was confirmed to be due to high construction vibration, then the contractor should repair the damage.

6.0 CONCLUSION

We have assessed the potential construction noise and vibration effects related to the establishment of a new Comprehensive Care Retirement Village in Karori, Wellington. Based on the preliminary construction methodology information we have received, we conclude that:

- Construction noise levels are predicted to comply with the 70 dBA L_{eq} noise limit (7:30am – 6pm Monday to Saturday) of NZS 6803:1999 at most assessment locations and for most construction activities across the Site;
- Exceedances of up to 11 dB are predicted for the closest dwellings for the concrete panel cutting at Allen Ward Hall. No mitigation can be implemented due to the height of the works, although the works will occur for a short duration. Alternative cutting techniques may be considered when the construction methodology is finalised;
- Exceedance of up to 7 dB are predicted for Karori Normal School and Karori Pool in relation to piling works that will occur for a limited duration. We recommend the CNVMP consider additional mitigation measures for these works near the School to ensure the noise does not exceed a reasonable level. No additional mitigation measures are recommended in relation to Karori Pool;
- All other activities will generally comply with, or only marginally exceed to a non-noticeable extent, the 70 dB L_{Aeq} limit of NZS 6803:1999;
- Any one receiver will not be exposed to high noise activities for the entire construction period, but only during the construction activities closest to them, and for intermittent and limited durations;
- Some dwellings closest to the construction activities may be exposed to construction vibration levels from vibratory compaction, that may approach and at times exceed the vibration limit. For vibratory works near these dwellings, alternative compaction measures should be investigated and/or building condition surveys offered;
- We consider that with the implementation of a CNVMP, construction noise and vibration effects can be managed to be reasonable and generally within the standards of NZS 6803:1999 and DIN 4150-3:2016;
- We recommend that the preparation of a CNVMP is included as a condition of consent on the project.

APPENDIX A GLOSSARY OF TERMINOLOGY

Noise	A sound that is unwanted by, or distracting to, the receiver.
SPL or L_P	<u>Sound Pressure Level</u> A logarithmic ratio of a sound pressure measured at distance, relative to the threshold of hearing (20 μPa RMS) and expressed in decibels.
SWL or L_W	<u>Sound Power Level</u> A logarithmic ratio of the acoustic power output of a source relative to 10^{-12} watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
dB	<u>Decibel</u> The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 μPa i.e. dB = 20 x log(P/Pr)
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
L_{eq}	The equivalent continuous (time-averaged) sound level. This is commonly referred to as the average noise level.
L_{max}	The maximum noise level. The highest noise level which occurs during the measurement period.
Vibration	When an object vibrates, it moves rapidly up and down or from side to side. The magnitude of the sensation when feeling a vibrating object is related to the vibration velocity. Vibration can occur in any direction. When vibration velocities are described, it can be either the total vibration velocity, which includes all directions, or it can be separated into the vertical direction (up and down vibration), the horizontal transverse direction (side to side) and the horizontal longitudinal direction (front to back).
PPV	<u>Peak Particle Velocity</u> For Peak Particle Velocity (PPV) is the measure of the vibration aptitude, zero to maximum. Used for building structural damage assessment.

APPENDIX B SUBJECT SITE AND SURROUNDING PROPERTIES

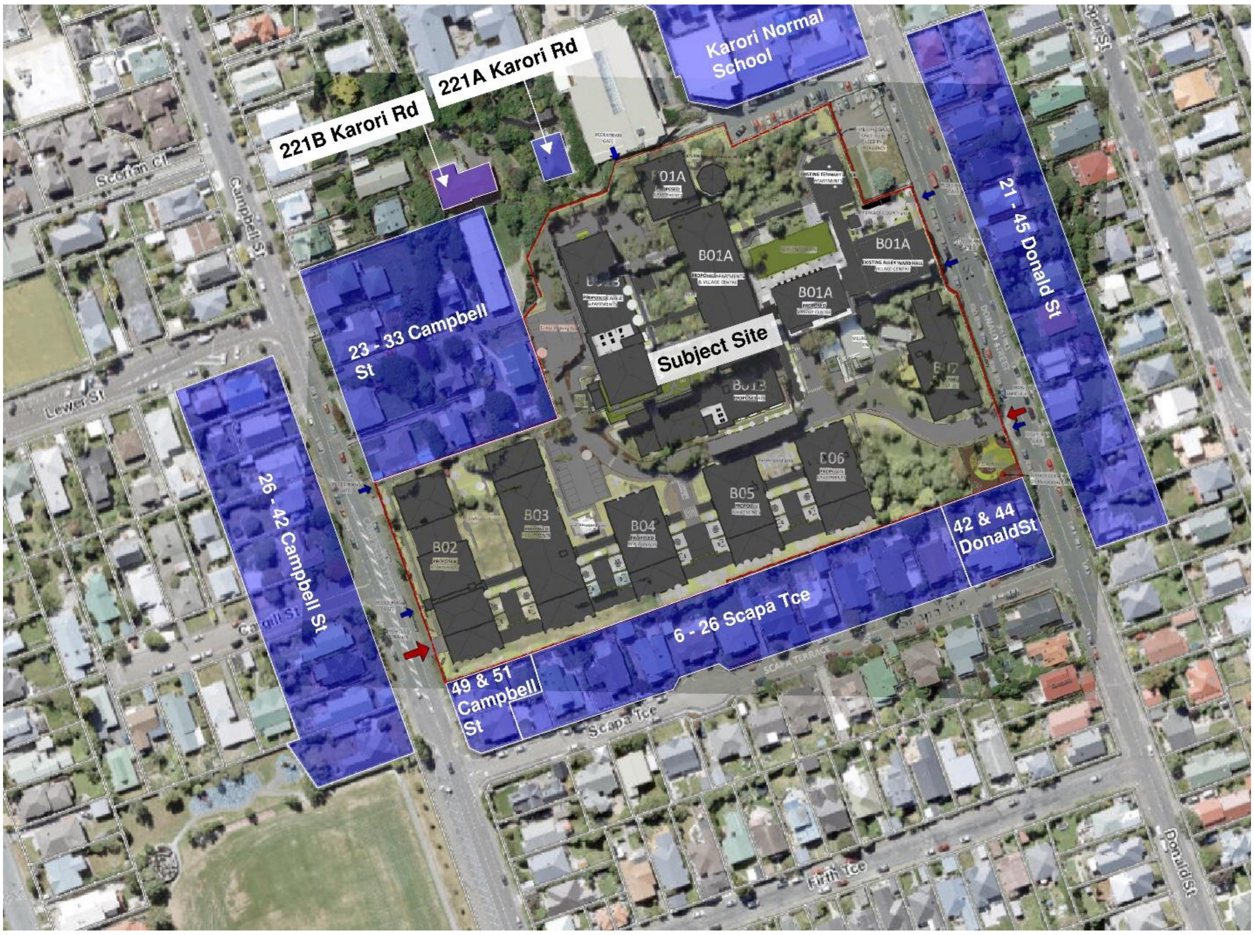
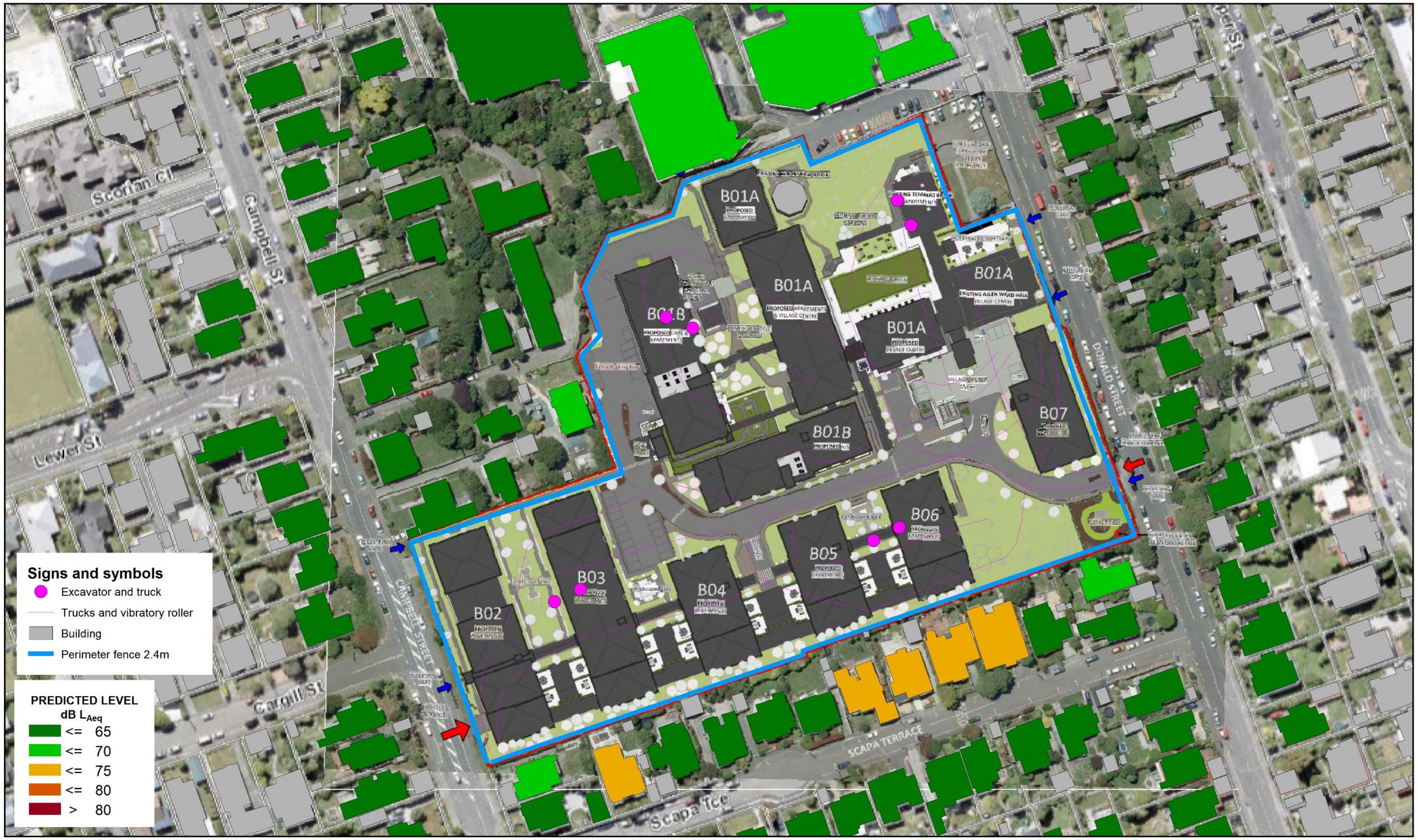
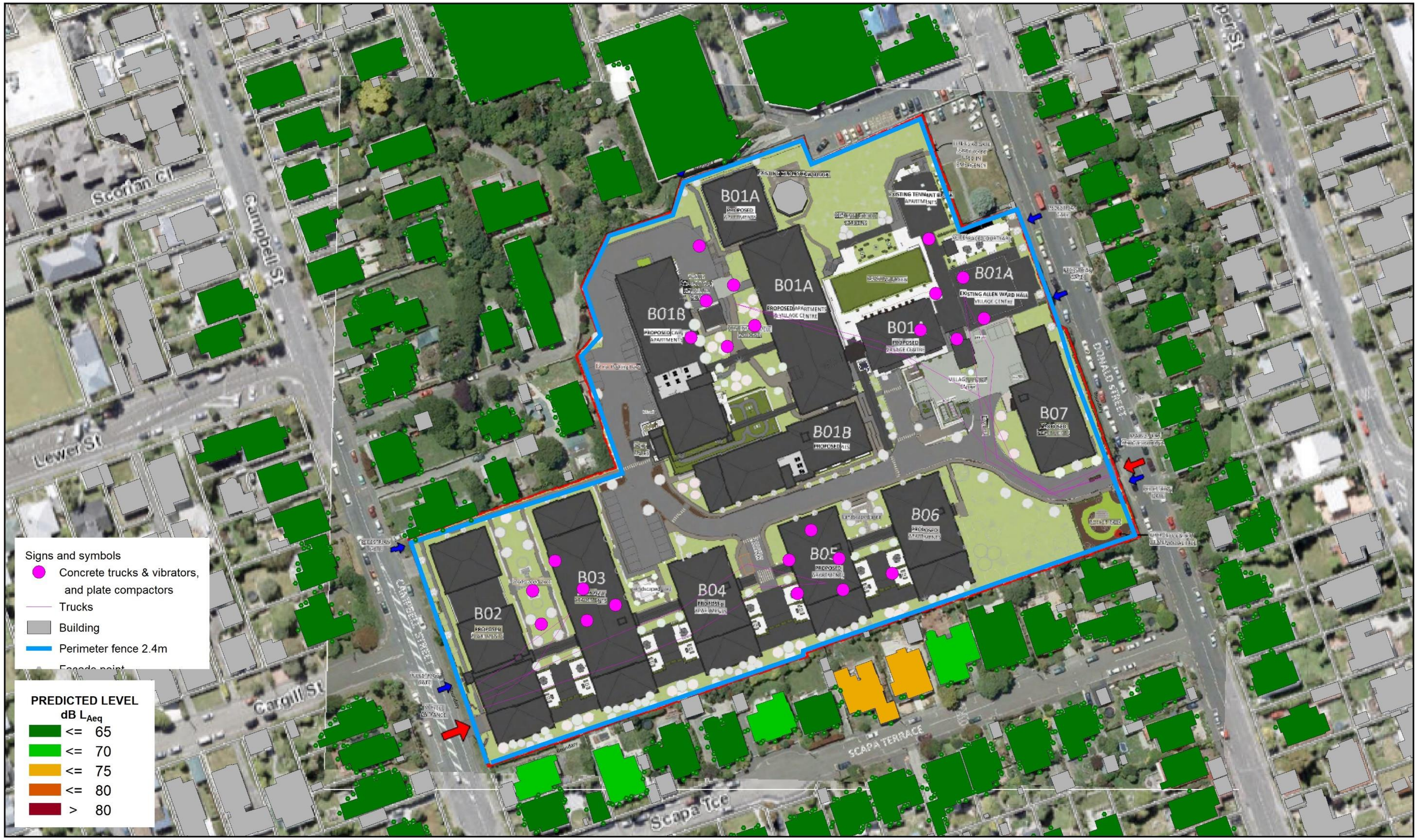


Figure B1: Subject site and closest potentially affected locations (*base image: WCC GIS*).

APPENDIX C PREDICTED CONSTRUCTION NOISE LEVELS



Version: SoundPLAN 8.2	Project: Ryman Karori	Site Preparation
Prediction method: ISO9613-2:1996	Project number: 20200396	
	Client name: Ryman Healthcare	
File: MDA_Site Prep SW	SCALE 0 10 20 40 60 80 m	MARSHALL DAY Acoustics
Prediction Height: 1.5 metres		



N

Version: SoundPLAN 8.2

Prediction method: ISO9613-2:1996

File: MDA_Slab SW

Prediction Height: 1.5 metres

Project: Ryman Karori

Project number: 20200396

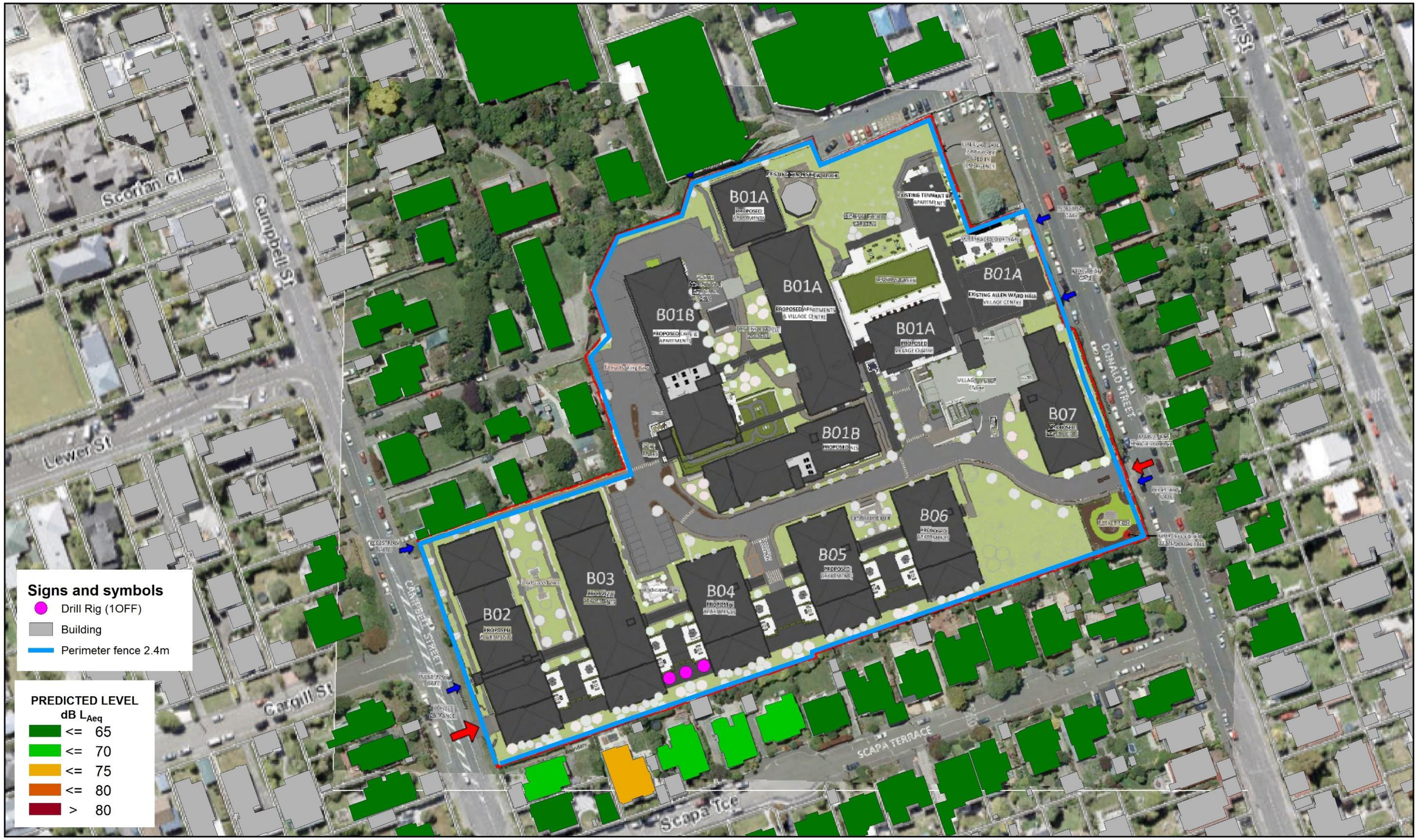
Client name: Ryman Healthcare

SCALE

0 10 20 40 60 80 m

Slab Construction

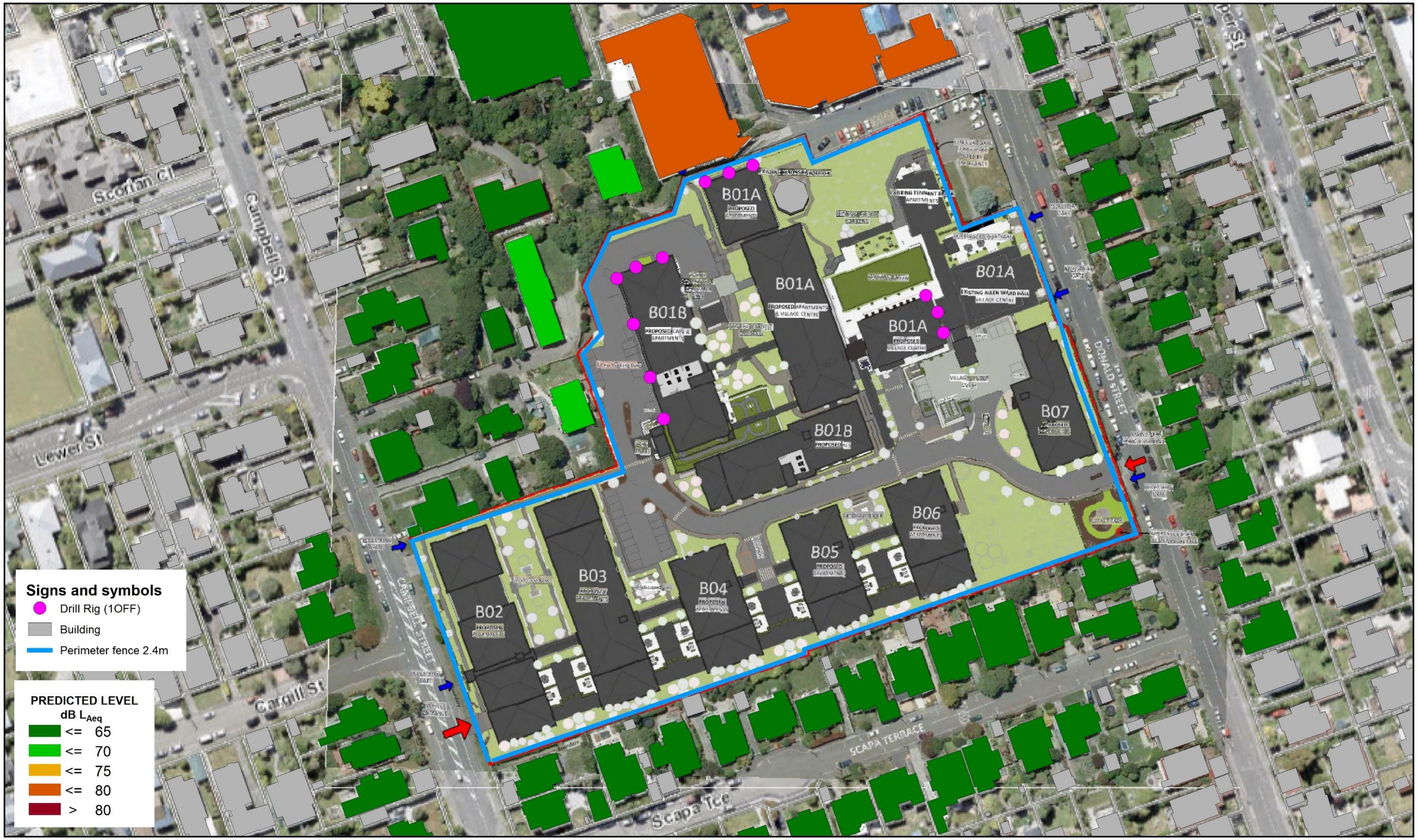
MARSHALL DAY Acoustics



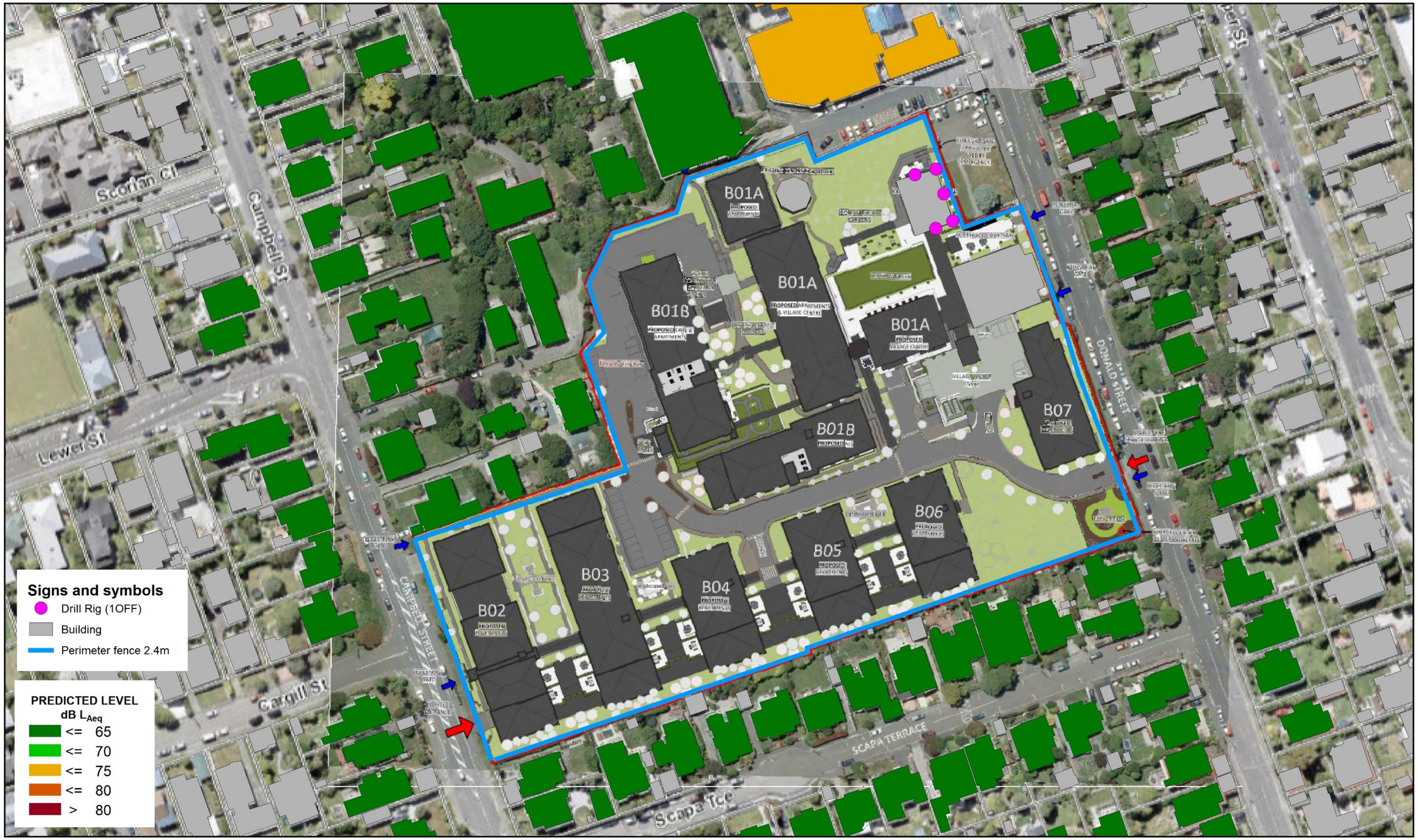
Version: SoundPLAN 8.2	Project: Ryman Karori
Prediction method: ISO9613-2:1996	Project number: 20200396
File: MDA_Area 1 Piling SW	Client name: Ryman Healthcare
Prediction Height: 1.5 metres	SCALE 0 10 20 40 60 80 m

Area 1 Stormwater Tank Piling

MARSHALL DAY Acoustics



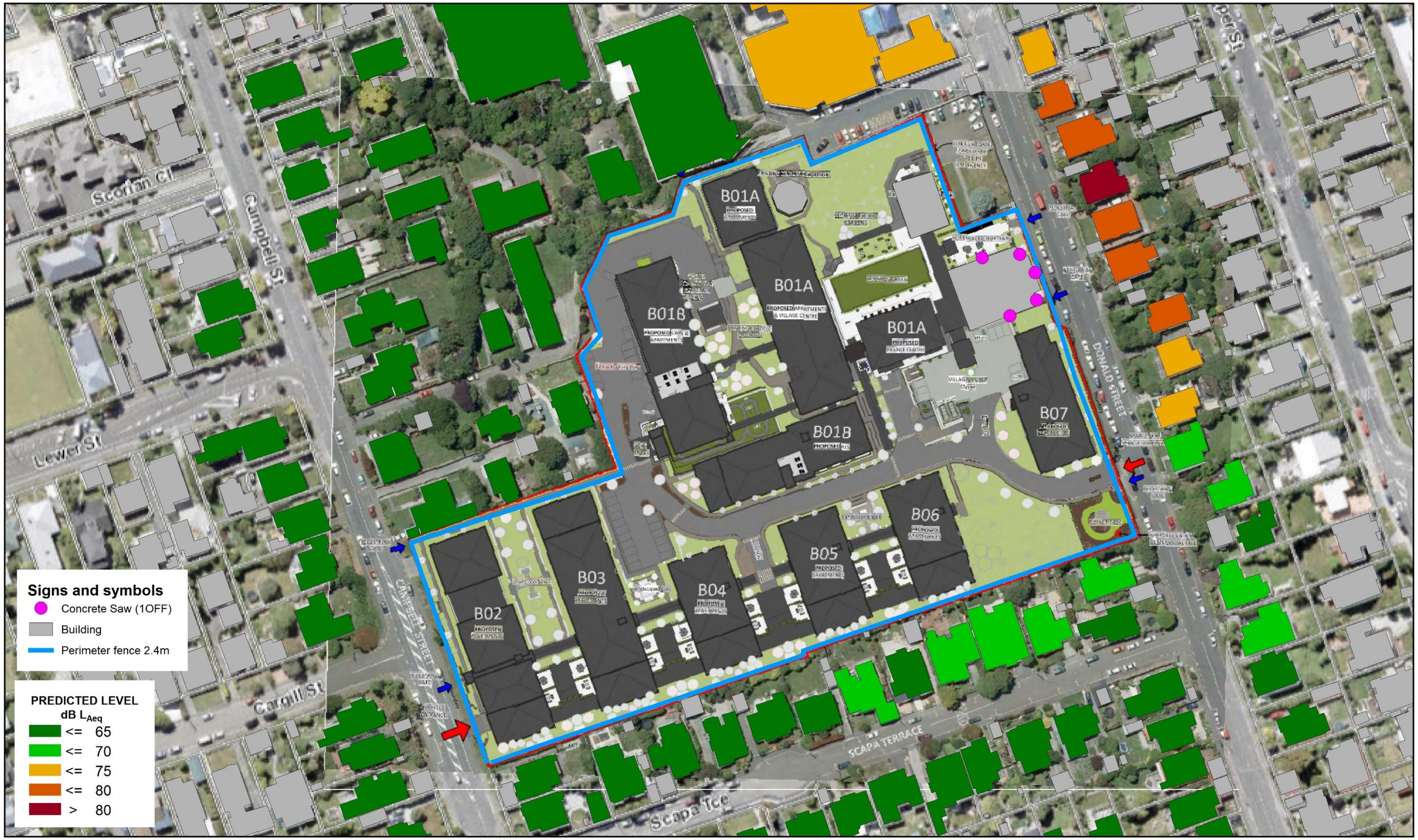
Version: SoundPLAN 8.2	Project: Ryman Karori	Building B01A and B01B Piling
Prediction method: ISO9613-2:1996	Project number: 20200396	
	Client name: Ryman Healthcare	
File: MDA_Piling B01A_B01B SW	SCALE 0 10 20 40 60 80 m	MARSHALL DAY Acoustics
Prediction Height: 1.5 metres		



Version: SoundPLAN 8.2	Project: Ryman Karori
Prediction method: ISO9613-2:1996	Project number: 20200396
	Client name: Ryman Healthcare
File: MDA_Tennant Block Piling SW	SCALE 0 10 20 40 60 80 m
Prediction Height: 1.5 metres	

Tennant Building Piling

MARSHALL DAY Acoustics



Version: SoundPLAN 8.2	Project: Ryman Karori	**Allen Ward Hall Concrete Sawing**
Prediction method: ISO9613-2:1996	Project number: 20200396	
	Client name: Ryman Healthcare	
File: MDA_Allen W Saws SW	SCALE 0 10 20 40 60 80 m	MARSHALL DAY Acoustics
Prediction Height: 1.5 metres		