Prepared For: M Projects

RIDBC
Centre of Excellence
Macquarie University

Noise Impact Assessment

White Noise Acoustics
303, 74 Pitt Street,
Sydney NSW 2000

ABN: 35 632 449 122

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1 Introduction

This Noise Impact Assessment has been prepared by White Noise Acoustics on behalf of the Royal Institute for Deaf and Blind Children (RIDBC) (the Applicant). It accompanies the State Significant Development Application (SSD-10451) for the RIDBC Centre of Excellence at Macquarie University.

This assessment includes the acoustic investigation into the potential for noise impacts from the operation of the RIDBC Centre of Excellence at Macquarie University project as well as the required noise and vibration management during the construction phases of the project.

2 Site Location

The RIDBC Centre of Excellence is located within Macquarie University precinct. The site is located to the south west of Gymnasium Road and to the north of the exiting Macquarie University Sports and Aquatic Centre.

The site location is detailed in Figure 1 below.

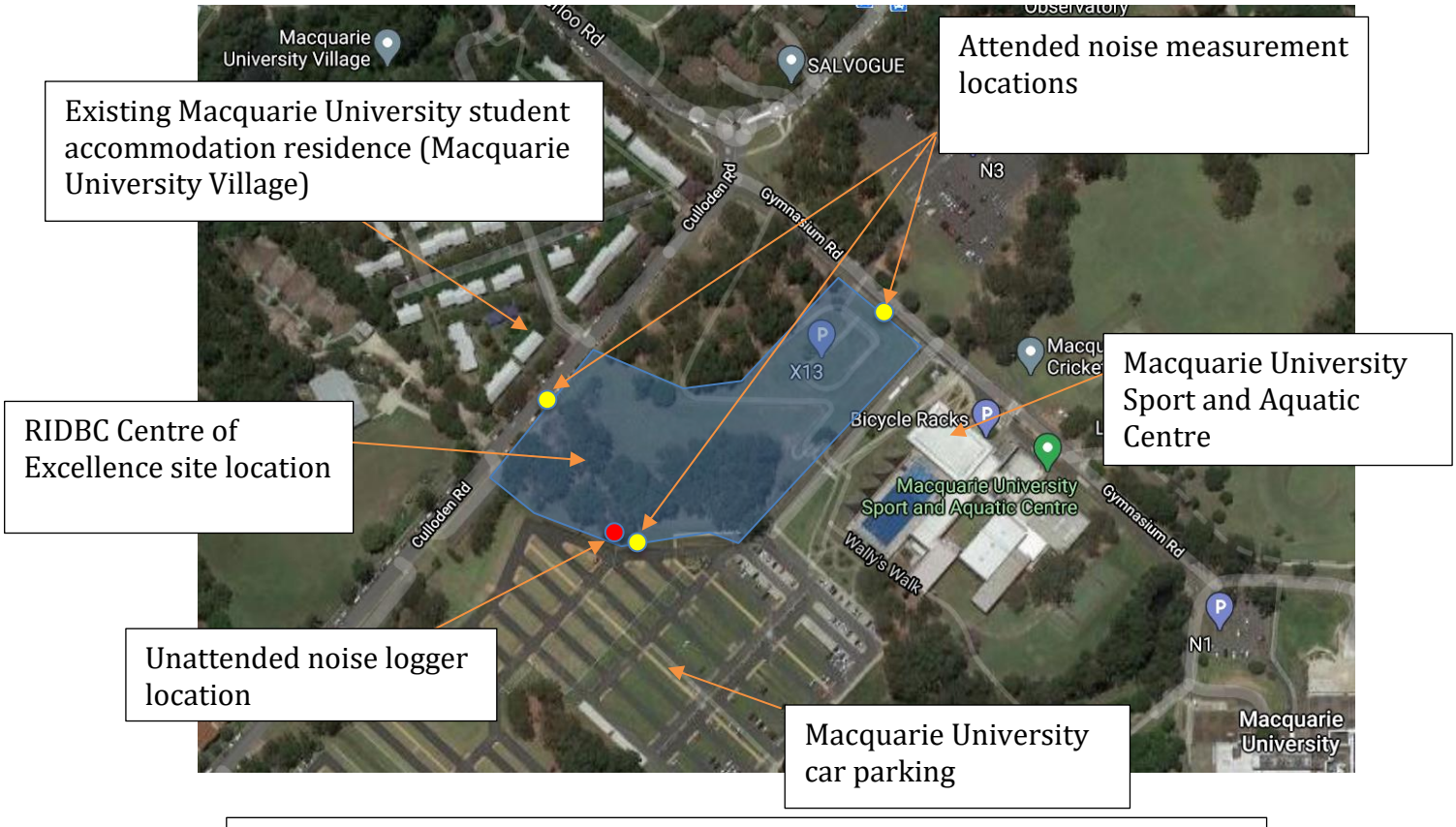


Figure 1 – RIDBC Centre of Excellence Site Location including surrounding receivers and Measurement Locations

The proposed RIDBC Centre of Excellence includes the construction of a new building on the site to include the future learning facility. The proposed development includes areas for external play, administration areas as well as internal teaching spaces with the main access of Culloden Road.

The proposed development is detailed in the figure below which included the proposed ground floor levels of the project.

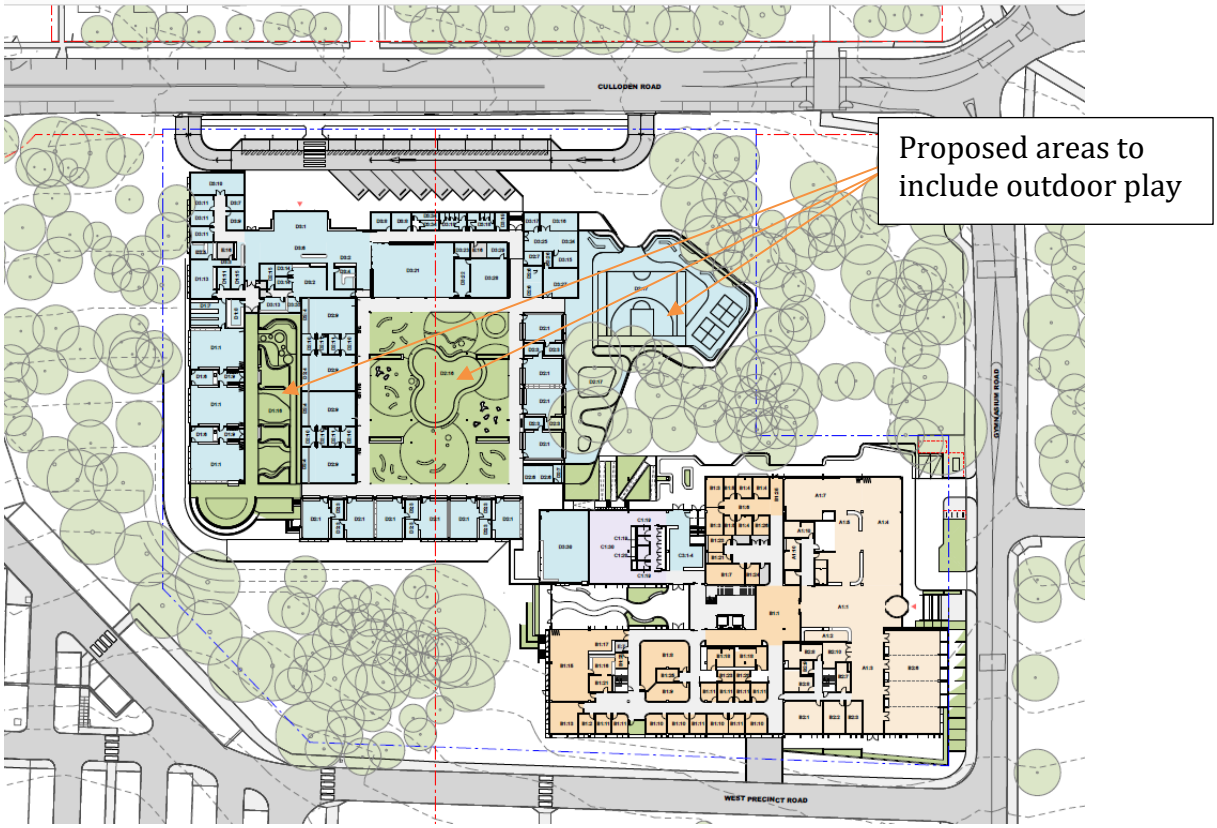


Figure 2 – RIDBC Centre of Excellence, Ground Floor Level

3 Proposed Development

The RIDBC is Australia's largest non-government not-for-profit provider of therapy, education and cochlear implant services for children and adults with vision or hearing loss. Established in 1861 as a school with residential facilities, the RIDBC moved to North Rocks in 1961, where the main campus is still located. The RIDBC Mission is to provide quality and innovative services, to achieve the best outcomes for current and future generations of Australians with vision and/or hearing loss.

RIDBC provides a broad range of specialist services which include:

- Early Intervention;
- Allied Health & Therapy;
- Cochlear Implant Program;
- Schools (pre-school, primary to secondary programs);
- Research & Professional Education;
- School support; and
- Pediatric Audiology

The services provided are delivered by a broad group of professionals including: teachers, speech pathologists, occupational therapists, audiologists, orthoptists, psychologists, social workers, technology consultants, physiotherapists, Ear, Nose and Throat (ENT) surgeons and more.

As part of the RIDBC's 2016-2020 Strategic Intent it will relocate its school and clinical services activities from North Rocks to a purpose-built center at Macquarie University (MQU). The new Centre of Excellence will further strengthen the relationship between MQU and the RIDBC, benefit the Australian Hearing Hub, and reinforce the cluster of research, audiology, and healthcare which already exists on the campus, which also includes the Cochlear Global headquarters.

The Centre of Excellence will serve a diverse range of employees, students, users and visitors who will visit the center for diagnostic services, therapy and rehabilitation, research, education, and co-related services. The center will provide an intricate design response to the needs of the users, in particular children and adults with vision and hearing loss and other cognitive impairments.

The proposed development generally seeks consent for the construction and operation of the new purpose-built 1-3 story (including basement level) Centre of Excellence across two interconnected pavilions at the corner of Culloden and Gymnasium Road within the MQU Campus. The development includes:

- Pre-School and School accommodation for up to 80 pre-school children and up to 120 school children in a single-story pavilion addressing Culloden Road; and
- The main RIDBC building (accommodating approximately 260 staff) of up to three stories, including basement level:
    - Public areas for staff and visitors;
    - RIDBC Renwick Centre classrooms (doubling also as conferencing facilities) and a business hub;
    - Medical Facility for various clinical services; and
    - RIDBC Renwick Centre resource centre; use between RIDBC Renwick Centre staff, clinicians and pre-school / primary school teaching staff.

In accordance with Schedule 1 (clause 15(1)) of *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP), the development qualifies as State Significant Development (SSD) as it is a *development for the purpose of a new school (regardless of the capital investment value)*.

The Secretary's Environmental Assessment Requirements (SEARs) for the development were issued on 6 May 2020 setting out the documentation and reporting requirements for the preparation of the EIS / DA.

This report includes the response to Item 12 of the SEAR/s (Noise and Vibration), including the following:

> • *Identify and provide a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation, construction. Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.*
>
> Included in Section 8.5 of this report.
>
> • *Identify and assess operational noise, including consideration of any public-address system, school bell, mechanical services (e.g. air conditioning plant), use of any school hall for concerts etc. (both during and outside school hours) and any out of hours community use of school facilities, and outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.*
>
> Detailed assessment, as required is included in Section 6 and 7 of this report.
>
> ***Relevant Policies and Guidelines:***
> • *NSW Noise Policy for Industry 2017 (NSW Environment Protection Authority (EPA)*
> • *Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009)*
> • *Assessing Vibration: A Technical Guideline 2006 (Department of Environment and Conservation, 2006)*
> • *Development Near Rail Corridors and Busy Roads - Interim Guideline (Department of Planning, 2008)*

4 Existing Acoustic Environment

The RIDBC Centre of Excellence project is located within the existing Macquarie University precinct. The site is located within an area which does not include significant transportation, industrial or commercial noise sources. Neighbouring the site are the Macquarie University Sport and Aquatic Centre as well as carparking associated with Macquarie University.

The site is located to the south west of Gymnasium Road and the surrounding areas include the following receivers:

1. Residential receivers located within the Macquarie University Village to the north west of the site.
2. The existing Macquarie University Sports and Aquatic Centre located to the south east of the site.

The receiver locations are detailed in Figure 1 of this report above.

Providing noise level emissions comply at the locations detailed above compliance at all surrounding receivers will be achieved.

4.1 Noise Survey Results

As part of this assessment an acoustic survey of the existing acoustic environment at the site was undertaken. The survey included attended noise level measurements at the site, during various times of the day on the 3rd September 2020 as well as long term unattended noise logging which was undertaken between the 3rd and the 10th September 2020.

Noise logging was undertaken using a ARL Rion type noise monitor with serial number 00998079 and calibration with calibration number C19678. The noise logger was located on the site as detailed in Figure 1 above. The logger was positioned such that it was in a free field location and façade corrects were not required to be applied within the existing vegetate area on the site.

Attended noise testing was conducted using a Bruel and Kjaer 2236C type meter. The meter was calibrated before and after testing and no significant drift was recorded.

The attended and unattended noise locations were selected to obtain suitable noise levels for the assessment of background noise levels ($L_{90\,(t)}$) as well as the impact from traffic movements ($Leq_{(t)}$). The results of the acoustic survey are detailed in the tables below which have been used as the basis of this assessment.

Table 1 – Results of the Attended Noise Survey at the Site

Measurement Location	Time of Measurement	Recoded Ambient Noise level $L_{eq, 15min}$ dB(A)	Background Noise Level $L_{90, 15min}$ dB(A)	Comments
Culloden Road	3.30pm to 3.45pm	66	46	Noise level at the site dominated by vehicle movements on surrounding roadways and the carpark to the south west of the site
Gymnasium Road	3.50pm to 4.05pm	62	43	
To the South west of the site	4.10pm to 4.25pm	59	43	

Table 2 – Results of the Noise Logging at the Site

Measurement Location	Time of Measurement	Maximum Repeatable $L_{Aeq, 15min}$ dB(A)	Representable Background noise Level (RBL) $L_{A90, 15min}$ dB(A)
Noise logger location, see figure 1 above	Day	54	43
	Evening	42	37
	Night	37	33

5 Internal Noise Level Criteria

Internal noise levels within the future residential occupancies have been based on the relevant noise levels as detailed within the Australian Standard AS2107:2000 *Acoustics - Recommended design sound levels and reverberation times for building interiors* and the *Educational Facilities Standards Design Guide.*

The required internal noise levels detailed within the standards are included in the sections below.

5.1 Australian Standard AS2107:2016

The Australian Standard AS2107:2016 *Acoustics - Recommended design sound levels and reverberation times for building interiors* and *Educational Facilities Standards Design Guide* recommended internal noise levels for various areas of a project. The recommended noise levels for the internal areas of the project detailed are included in the table below.

Table 3 – Recommended Internal Noise Levels AS2107:2016

Type of Occupancy/Activity	Design sound level maximum ($L_{Aeq,t}$)
Teaching Spaces	40
Interview rooms	40
Administration Offices	40
Toilets	55
Common Areas	50
Boardrooms	35
Meeting Rooms	40
Open Plan Offices	45
Note: The relevant time period (t) for all areas detailed is 15 minutes.	

5.2 Environmental Noise Intrusion Assessment

This section of the report details the assessment of environmental noise intrusion into the proposed development and the recommended acoustic treatments to ensure the recommended internal noise levels detailed in the Sections above (including traffic and environmental noise) are achieved.

Internal noise levels within the future areas of the development will result from the noise intrusion into the building through the external façade including glass, masonry and other façade elements.

Typically, the acoustic performance of building elements, including the relatively light weight elements of the building façade, such as glass and/or plasterboard constructions will be the determining factors in the resulting internal noise levels.

Calculations of internal noise levels have been undertaken based on the measured traffic and calculated aircraft environmental noise levels at the site as well as the characteristics of the building, including window openings, buildings construction materials and the like including the measured environmental noise levels detailed in Section 4 above.

In addition to the measured noise levels of the site an assessment of the potential for environmental noise levels resulting from the use of the Macquarie University Sports and Aquatic Centre has been undertaken. At the time of this assessment being conducted restrictions on the operation of the sport and aquatic centre resulting from Covid 19 where in place. As a result, noise emission measurements from the sports and aquatic centre could not be undertaken. For the purpose of this assessment an assumed noise levels resulting from noise generated from an aquatic centre being used for a sports event (including measurement of North Sydney pool with a school carnival in operation) have been used in this assessment with a noise level of 65 dB(A) $L_{eq\ (15min)}$ at the future south façade of the RIDBC Centre facing the Macquarie University Sports and Aquatic Centre.

5.3 External Glass Elements

The recommended acoustic constructions to the buildings external façade glass elements are detailed in the table below to ensure the recommended internal noise levels detailed above are achieved, with the façade building openings closed.

Table 4 – External Glass Acoustic Requirements

Façade Orientation	Levels	Room Type	Recommended Glass Construction	Minimum Façade Acoustic Performance[1]
All Façade orientation	All Levels	All Room Types	6.38mm Laminated	Rw 30
Note 1: *The acoustic performance of the external façade includes the installed glazing and frame including (but not limited to) the façade systems seals and frame. All external glazing systems are required to be installed using acoustic bulb seals.*				

The recommended glass constructions detailed in the table above include those required to ensure the acoustic requirements of the project are achieved. Thicker glazing may be required to achieve other project requirements such as structural, thermal, safety or other requirements and is to be advised by others.

5.4 External Building Elements

The proposed external building elements, including masonry or concrete external walls and roof, are acoustically acceptable without additional acoustic treatment.

Any lightweight external pasteboard walls should be constructed from a construction with a minimum acoustic performance of Rw 45.

5.5 External Roof

The required external roof and ceiling constructions for the project are required to include the following:

1. Concrete external roof construction – no additional acoustic treatments required.
2. Metal deck roof construction – no additional acoustic treatments required.

5.6 External Opening and Penetrations

All openings and penetrations are required to be acoustically treated such that the performance of the building construction is not compromised. This may require lining of duck work behind mechanical service openings/grills, treatments to ventilation opening and the like.

6 Operational Noise Level Criteria

This section of the report details the relevant noise level criteria for noise emissions from the site once completed.

As the site includes a facility containing a school or learning centre there are no relevant Environmental Protection Authority (EPA) criteria. There are a number of relevant authority and guidelines which provide suitable acoustic criteria for noise emissions from a school site, including the following:

1. NSW Environmental Protection Authority, Noise Policy for Industry (formally the Industrial Noise Policy) – Suitable for the assessment of mechanical services noise emissions from the site.
2. Association of Australian Acoustical Consultants (AAAC) guideline for Child Care Centre Acoustic Assessment, October 2013 – Including recommended criteria for noise emissions generated from use of Outdoor Play Areas.

Details of the resulting acoustic criterion based on the standards detailed above are included in the following sections.

6.1 NSW Environmental Protection Authority, Noise Policy for Industry

The NSW Environmental Protection Authority (EPA) Noise Policy for Industry (NPfI), previously Industrial Noise Policy, details noise criteria for the control of noise generated from the operation of developments and the potential for impact on surrounding receivers.

The NPfI includes both intrusive and amenity criteria which are summarised below and have been used for the assessment of services noise including mechanical equipment.

1. Intrusive noise level criteria. The NPI states the following:

   'The intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (represented by the LAeq descriptor), measured over a 15minute period, does not exceed the background noise level by more than 5 dB when beyond a minimum threshold. This intrusiveness noise level seeks to limit the degree of change a new noise source introduces to an existing environment.'

2. Amenity noise level criteria. The NPfI states the following:

   'To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance.'

Project amenity noise level for industrial developments = recommended amenity noise level (Table 2.2) minus 5 dB(A)

Where the resultant project amenity noise level is 10 dB or more lower than the existing industrial noise level. In this case the project amenity noise levels can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

The LAeq is determined over a 15-minute period for the project intrusiveness noise level and over an assessment period (day, evening and night) for the project amenity noise level. This leads to the situation where, because of the different averaging periods, the same numerical value does not necessarily represent the same amount of noise heard by a person for different time periods. To standardise the time periods for the intrusiveness and amenity noise levels, this policy assumes that the LAeq,15min will be taken to be equal to the LAeq, period + 3 decibels (dB), unless robust evidence is provided for an alternative approach for the particular project being considered.

Project amenity noise level (ANL) is urban ANL (Table 2.1) minus 5 dB(A) plus 3 dB(A) to convert from a period level to a 15-minute level (dB = decibel; dB[A] = decibel [A-weighted]; RBL = rating background noise level).

Noise level used in the assessment of noise emission from the site have been based on the noise level survey conducted at the site and detailed in this section of the report.

The resulting noise level criteria are summarised in the table below. The criteria are nominated for the purpose of determining the operational noise limits for the operation of the site including mechanical plant associated with the development which can potentially affect noise sensitive receivers and operational noise levels from the future tenancies. For each assessment period, the lower (i.e. the more stringent) of the amenity or intrusive criteria are adopted. The calculated *Project Amenity Noise Level* includes either the Recommended Amenity Noise Level minus 5 dB(A) plus 3 dB(A) (for a 15minum period) or the measured existing Leq noise level – 10 dB if this is greater as determined by the NPfI.

The resulting project Trigger Noise Levels are detailed in the following table.

Table 5 – External Noise Level Criteria in Accordance with the NSW NPI

Location	Time of Day	Project Amenity Noise Level, $L_{Aeq, period}$ [1] (dBA)	$L_{A90, 15\ min}$ (RBL) [2] (dBA)	$L_{Aeq, period}$ Noise Level (dBA)	Intrusive $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA)
Residential Receiver – Macquarie University Village	Day	53	43	54	**48**
	Evening	43	37	42	**42**
	Night	**38**	33	37	38
Commercial Receiver – Macquarie University Sports and Aquatic Centre	When in Use	**65**	40	56	-

Note 1: Project Amenity Noise Levels corresponding to "Suburban Residential" areas, recommended noise levels.

Note 2: L_{A90} Background Noise or Rating Background Level

Note 3: Project Noise Trigger Levels are shown in bold

6.2 AAAC Guideline for Child Care Centre Acoustic Assessment

Noise from the use of the external play areas on the site cannot be assessed using the standard EPA or council guidelines. Noise generated from the use of outdoor play areas does not include noise that is similar to typical industrial noise sources such as mechanical equipment, heavy vehicles, manufacturing or the like. Noise associated from the use of outdoor play areas associated with schools is generally assessed to a less stringent requirement than the noise emission criteria detailed within the EPA NPI (detailed in the section above) for a number of reasons including the following:

1. Noise generated from the use of outdoor play areas from schools is identified as being for the benefit of the general community.
2. Noise generated from outdoor play areas will be generated during limited periods of the day, including lunch breaks and after school. Organised play and use of the school will generally be limited to Monday to Friday.
3. Noise generated from the use of outdoor play areas does not result in noise with the potential to impact on the reasonable amenity of residential receivers compared to industrial or commercial noise emissions. Noise from the use of students during normal operating hours will include supervision by teaching staff.
4. Methods of noise control from outdoor play areas can be limited. The treatments required to reduce noise from outdoor play areas to within EPA NPfI noise criteria would result in significant impact as a result of acoustic screenings, buildings or the like.

The Association of Australian Acoustical Consultants (AAAC) Child Care Centre Acoustic Assessment includes recommended acoustic criteria for the assessment of noise from outdoor play areas. This is not a mandatory criteria, but includes guidance for the assessment of noise from outdoor play areas in the absence of criteria within any other standards or guidelines.

The Association of Australian Acoustical Consultants (AAAC) Child Care Centre Acoustic Assessment includes the following with regards to the assessment of noise emissions from the use of outdoor play areas within childcare centres.

> **Residential Receptors**
>
> **Outdoor Play Area**
>
> For most centres as the duration of time that children are allowed to play outside is reduced then the overall noise impact reduces. Therefore, it is reasonable to allow a higher level of noise impact for a shorter duration of outdoor play. AAAC members regard that a total time limit of approximately 2 hours outdoor play per day (eg 1 hour in the morning and 1 hour in the afternoon) should allow an additional emergence above the background of 5 dB.
>
> **Up to 2 hours (total) per day** - The $L_{eq,15\ minute}$ noise level emitted from the outdoor play area shall not exceed the background noise level by more than 10 dB at the assessment location.
>
> **More than 2 hours per day** - The $L_{eq,15\ minute}$ noise level emitted from the outdoor play area shall not exceed the background noise level by more than 5 dB at the assessment location.
>
> The assessment location is defined as the most affected point on or within any residential receiver property boundary. Examples of this location may be:
>
> - 1.5 m above ground level;
> - On a balcony at 1.5 m above floor level;
> - Outside a window on the ground or higher floors.

Based on the recommended noise levels for the use of outdoor play areas from childcare centres within the AAAC Child Care Centre Assessment, the use of a background + 10 dB(A) criteria for noise generated from the use of outdoor play areas associated with the RIDBC Centre of Excellence project will be acoustically acceptable.

Based on the existing background noise levels recorded at the site, and detailed in Section 4 above, the resulting noise emission criteria use in this assessment are detailed in the following table.

Table 6 – Summary of Outdoor Play Areas Noise Emission Criteria

Location	Time of Day	Background Noise Level $L_{A90,\ 15min}$ dB(A)	Noise Emission Goals for Outdoor Play Aras $L_{AeqT,}$ dB(A)
Residential Receiver – Macquarie University Village	Day – 7am to 6pm	43	53
Commercial Receiver – Sports and Aquatic Centre	Day – 7am to 6pm	43	65

Note: As outdoor play areas will only be used during daytime hours the noise emission criteria for the out-door play areas are presented in the table above.

7 Noise Emissions Assessment

An assessment of noise generated on the site has been undertaken in this section of the report. The assessment of noise levels generated on the site are summaries below:

1. Mechanical Plant and Equipment.
2. Noise from the use of outdoor play areas.
3. Noise from other areas of the site including internal areas of the project.

The detailed assessment of the items detailed above are included in the following sections.

7.1 Mechanical Plant and Equipment

The proposed development will include various items of mechanical plant and equipment including heating and cooling equipment, supply and exhaust fans.

As the project is currently in the initial design Phases details of plant and equipment has not yet been undertaken and therefore a detailed assessment of the required acoustic treatments required to ensure noise levels comply with noise emission criteria detailed in Section 6.1 above cannot be provided at this time.

Experience with similar projects confirms that compliance with the relevant noise emission criteria for the site can be achieved. Details of the specific acoustic treatments will be undertaken as part of the ongoing project design and provided as part of the CC submission of the project.

To ensure that future selections of plant items meet external noise levels at neighbouring properties a proof of concept approach has been considered.

In our experience, for this type of development the following mechanical systems may be installed, and their associated sound power levels are outlined below.

- Ventilation fans – 80dB(A) (Lw)
- Toilet exhaust fans – 45dBA (Lw)
- Air Conditioning Condensers – 80dBA (Lw)
- Air cooled chillers – 95 dB(A) (Lw)

For the proposed ventilation systems, it is anticipated that the physical fans would be installed in a plant area on the roof of the project with mechanical ductwork moving air to the future areas of the project. A dedicated plant deck area could be provided on the roof of each the future building.

On the assumption of the Sound Power Levels above and the assumption that ductwork is acoustically treated with 50mm internal lining or attenuators (depending on the exact location), compliance with the required noise emission criteria at all surrounding receivers can be achieved.

Possible acoustic treatment to the major plant items expected on the site are summaried below:

1. Cooling equipment – acoustic silencers and or louvers may be required to the intake and exhaust of cooling equipment. Equipment will be installed with Variable Speed Devices (VSD) to reduce capacity and noise levels as required.
2. Supply fans – supply fans on the site will include acoustic treatments including internally lined ductwork and/or silencers as required to ensure noise emission criteria is achieved.
3. Exhaust fans – exhaust fans on the site will include acoustic treatments including internally lined ductwork and/or silencers as required to ensure noise emission criteria is achieved.
4. Emergency Equipment – mechanical services equipment associated with the site will be acoustically treated using lined ductwork and/or silencers such that the requirements of AS1668 are complained with.
5. Pumps, heaters, boilers and the like – other general equipment such as pumps, heaters, boilers and the like will be housed within the level 6 plantroom or other internal areas. Treatment to the building façade including linings and/or treatment to openings in the building such as acoustic louvers or lined ducting will be included to ensure noise levels comply with the projects noise emission criteria.

Details of the required mechanical services equipment and acoustic treatments required to ensure that the relevant noise level criteria is achieved will be provided as part of the *Construction Certificate* submission of the project.

Experience with similar projects confirms that all proposed plant and equipment required on the site can be acoustically treated using those detailed in the points above. Selections of the plant and equipment items and the resulting acoustic treatments will be undertaken as part of the ongoing design of the project and provided as part of the CC submission of the project.

As detailed selections of mechanical equipment is not possible at this Phase of the project noise levels of the proposed equipment is not known. As such, details of the required acoustic treatments are not possible to be specified at this Phase of a project.

7.2 Noise from Outdoor Play Areas

The proposed RIDBC Centre of Excellence project includes a number of outdoor play areas including the following:

1. External play area to the north east of the site.
2. Two internal courtyards play areas associated with the school.

The location of the proposed external play areas are detailed in the figure below.

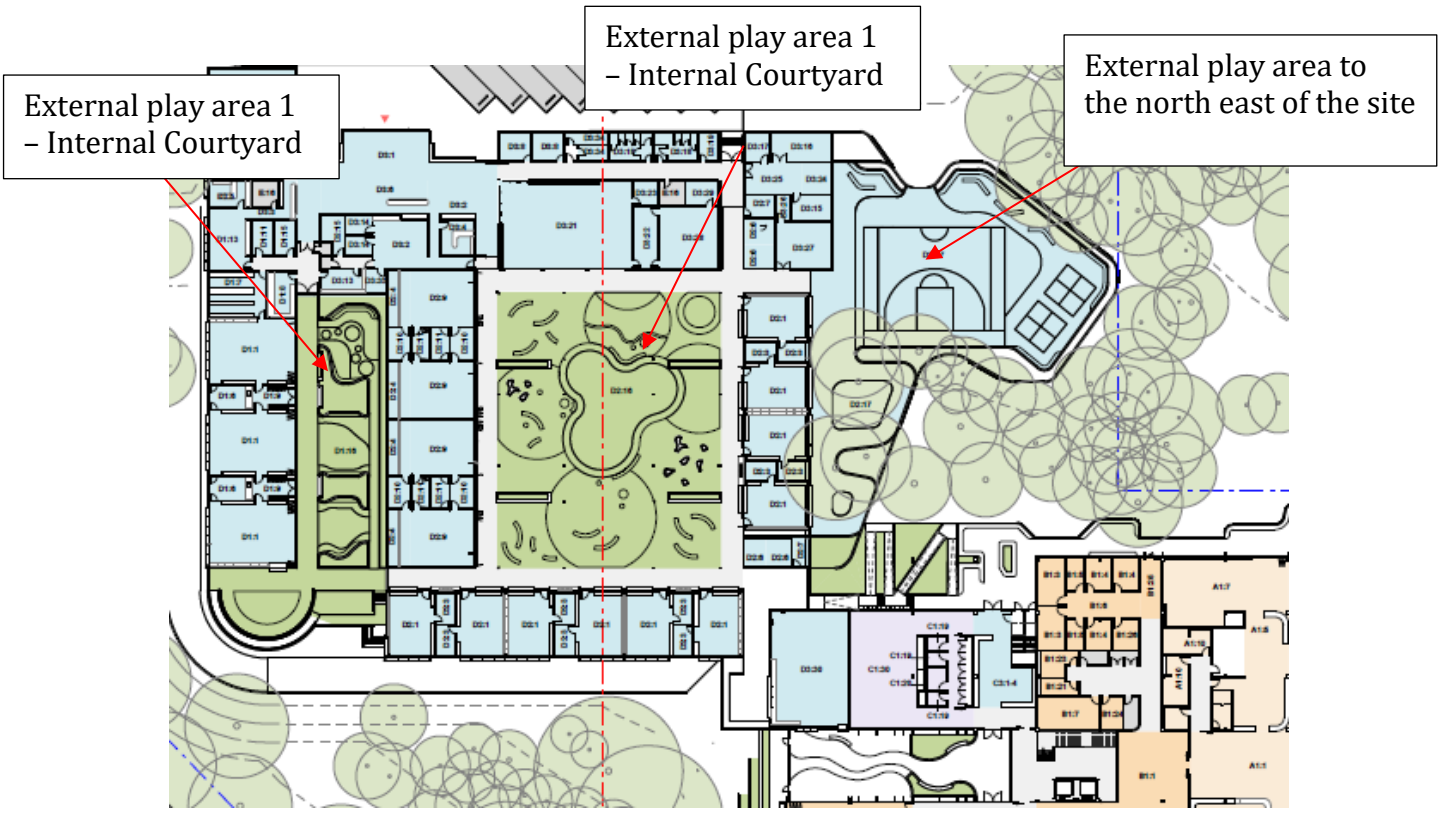


Figure 3 – External Play Areas

A detailed assessment for the potential noise impact from the use of the areas with potential outdoor play has been undertaken in this section of the report.

The location of the internal courtyard areas for outdoor play are located such that the surrounding building structure will act as an acoustic screen to the residential receivers located within the Macquarie University Village.

Based on the location of the outdoor play areas the following assumptions regarding noise generated from these areas has been used in this assessment:

1. The outdoor courtyard play areas are located to the ground floor of the project and the future building will result in an acoustic barrier to the neighbouring residential receiver.
2. Outdoor play areas will be used during periods of the day and can include the total number of students which are housed within the RIDBC Centre of Excellence project. The expected number of children using the external area includes the following:
    a. Outdoor courtyard 1 – Up to 80 children
    b. Outdoor courtyard 2 – Up to 120 children
    c. Outdoor play area to the north east - Up to 120 children
3. All areas of outdoor play will include supervision by teaching staff during the daytime hours of the school breaks.
4. Noise generated from the use of the outdoor play areas is based on the following:
    a. Source noise levels from active play based on SWL of 86 dB(A) Leq.

       The source noise level is the maximum of the range detailed within the AAAC's Guideline for Child Care Centre Acoustic Assessment, for groups of children playing age group including 3-6.

       The proposed source noise level is in the upper range of the AAAC expected source noise level for 3 to 6 year old's of 84-90 dB(A) for 10 children. Based on experience with similar school facilities to that of the RIDBC Centre of Excellence, the proposed source noise level of 86 dB(A) is suitable for the proposed use at the site including the proposed deaf and blind students which will be using the site.
    b. The source noise levels has been based on 1 in 2 children generating noise at any time within the proposed play areas at any time.

Based on the assumptions above, an acoustic assessment of noise emission impacts to the surrounding residential receivers has been undertaken and compared to the project noise level criteria for outdoor play of background + 10 dB(A). The results of the acoustic assessment are detailed in the table below.

Table 7 – Result of the Acoustic Assessment of Outdoor Play

Location	Time of Day	Calculated Noise Emissions from Play Aras $L_{Aeq\ 15min}$, dB(A)			Cumulative Noise Level $L_{Aeq\ 15min}$, dB(A)	Noise Emission Goals for Outdoor Play Aras $L_{Aeq\ 15min}$, dB(A)
		Courtyard 1	Courtyard 2	Outdoor area		
Residential Receiver – Macquarie University Village	Day time play periods	27	30	41	41.4	53
Commercial Receiver – Sports and Aquatic Centre	Day time play periods	23	26	38	38.4	65

Based on the results of the noise impact assessment from the external play areas compliance with the relevant noise emissions criteria will be achieved without additional acoustic mitigations or controls.

7.3 Mitigation of Outdoor Play Area Noise including Bells and PA Systems

To further mitigate noise from the use of the proposed outdoor play areas of the site the following acoustic treatments and controls are possible:

1. All audible school bells and speakers are to be located such that they face away from the residential receivers and set to an appropriate noise level of 70-75dB(A) @ 3m.
2. The use of directional speakers should be utilised on the external areas of the site for any public address systems.

7.4 Noise from use of the Proposed Drop Off Area

This section of the report details the acoustic assessment of noise generated from the proposed drop off area which is proposed for the main entry off Culloden Road.

The proposed Drop Off area is detailed in the figure below.

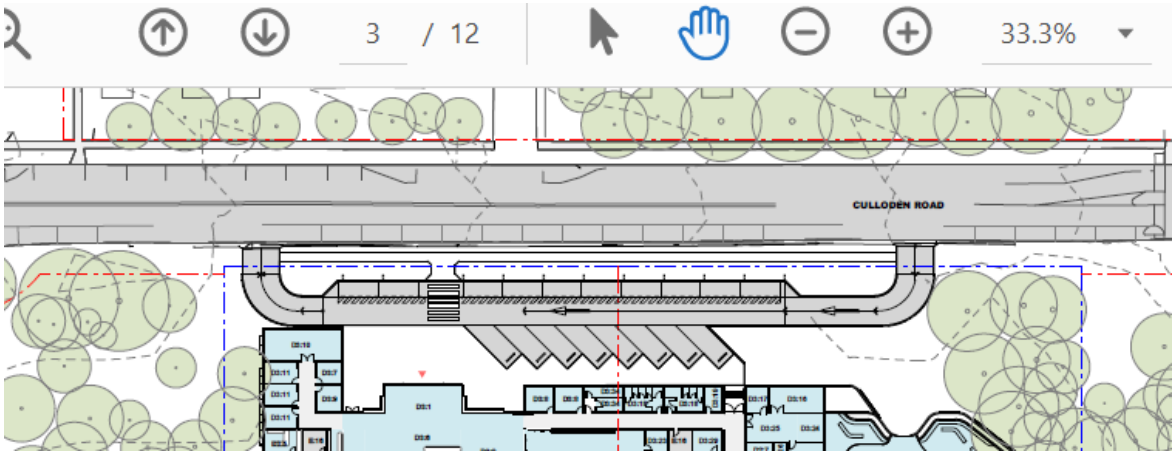


Figure 4 – Proposed Drop Off Area

The expected use of the proposed extended driveway will include the drop off students. For the purpose of this assessment the following movements in the drop off area have been assumed as part of this assessment:

1. Morning Peak periods, 1 hour period – up to 70 cars and 20 buses.
2. Afternoon peak periods, 1 hour period - up to 70 cars and 20 buses.

The assessment of noise from the use of the extended driveway has been undertaken using both the EPA's NPfI and the EPA's Road Noise Policy for New Local Road as a guide. The EPA's Road Noise Policy recommends noise levels from the operation of new local roads on existing residential receivers which is detailed in Section 2.3.1 of the policy, Table 3, which is included below.

Table 3 Road traffic noise assessment criteria for residential land uses

Road category	Type of project/land use	Assessment criteria – dB(A)	
		Day (7 a.m.–10 p.m.)	Night (10 p.m.–7 a.m.)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from **new** freeway/arterial/sub-arterial road corridors	$L_{Aeq, (15\ hour)}$ 55 (external)	$L_{Aeq, (9\ hour)}$ 50 (external)
	2. Existing residences affected by noise from **redevelopment** of existing freeway/arterial/sub-arterial roads 3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq, (15\ hour)}$ 60 (external)	$L_{Aeq, (9\ hour)}$ 55 (external)
Local roads	4. Existing residences affected by noise from **new** local road corridors 5. Existing residences affected by noise from **redevelopment** of existing local roads 6. Existing residences affected by **additional traffic** on existing local roads generated by land use developments	$L_{Aeq, (1\ hour)}$ 55 (external)	$L_{Aeq, (1\ hour)}$ 50 (external)

Suitable application of the proposed drop off area

The results of the acoustic assessment of cars and buses using the extended driveway on the potentially affected residential receivers is detailed in the table below.

Table 8 – Result of the Acoustic Assessment of Buses using Extended Driveway

Location	Time of Day	Calculated Noise Emissions from Buses and cars using Extended Driveway Road $L_{Aeq\ 1\ hour}$, dB(A)	EPA's Road Noise Policy for new Local Roads $L_{Aeq\ 1hour}$, dB(A)	Comments
Residential Receiver – Macquarie University Village	Peak pick up and drop off	Up to 51	55	Compliant

Based on the results of the assessment of noise generated from the use of the proposed drop off area there will be no adverse acoustic impact of the amenity of the surrounding residential receivers, including those located within the Macquarie University Village.

In addition to the assessment detailed above, comments regarding the resulting noise levels resulting from the use of the drop off area as a result of the morning and afternoon peal periods follow:

1. The noise associated with the morning and afternoon peak periods will be limited to a period of generally 7.30am to 9am and an afternoon period of 2.30pm to 4.30pm.
2. Noise levels generated from vehicles using the drop off area will be mitigated by the distance separation between the area and the Macquarie University Village dwellings which is approximately 35m.
3. The assessment includes the resulting noise level to the external areas of the residential receivers which are compliant with the relevant noise level criteria. As an additional mitigation, in the event of the external building openings being closed (including windows and doors) there will be a further reduction.

Based on the detailed assessment included in this section of the report, and the comments above, the proposed drop off area will be acoustically acceptable for the proposed future use as part of the RIDBC Centre of Excellence project.

7.5 Noise from Internal Areas

This section of the report details the assessment of noise emissions from the internal areas of the RIDBC Centre of Excellence.

All internal areas of the RIDBC Centre of Excellence will be located within the building envelope which includes a closable external façade with a minimum acoustic performance of Rw 30. This includes 6.38mm laminated glazing (or greater) and solid light weight or concrete building elements.

The potentially high noise generating sources within the building, including the areas with teaching and presentations, are located without external opening to the external façades to the north west of the building which face towards the residential receivers within the Macquarie University Village.

Providing the external façade openings of the building are closed during periods when high noise activities are being generated, such as gatherings in the public entry foyer area, the noise levels at all surrounding receivers, including the residences within the Macquarie University Village, will comply with the noise emission criteria detailed in Section 6.1 of this report and will be acoustically acceptable.

7.6 Other Impacts

The control of noise generated on the site from a number of other activities has been undertaken and the following management is required to mitigate noise impacts on surrounding receivers.

1. Waste collection from the site is required to be undertaken in compliance with council polices including times when waste is removed from the site. Where possible waste should be collected from the site during daytime hours.
2. The use of noise generating equipment for ground maintenance and upkeep (such as leaf blowers, brush cutters, lawn mowers and the like) are only to be undertaken during daytime hours.

8 Construction Noise Assessment

This section of the report details the assessment of noise associated with the proposed excavation and construction activities associated with the development. The assessment has been undertaken to assess the potential noise impacts from construction and excavation on surrounding receivers to the site.

The EPA's Interim Construction Noise Guideline defines normal day time hours as the following:

2.2 Recommended standard hours

The recommended standard hours for construction work are shown in Table 1; however, they are not mandatory. There are some situations, as described below, where construction work may need to be undertaken outside of these hours. The likely noise impacts and the ability to undertake works during the recommended standard hours should be considered when scheduling work.

Table 1: Recommended standard hours for construction work

Work type	Recommended standard hours of work*
Normal construction	Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays
Blasting	Monday to Friday 9 am to 5 pm Saturday 9 am to 1 pm No blasting on Sundays or public holidays

* The relevant authority (consent, determining or regulatory) may impose more or less stringent construction hours.

The proposed hours of work for construction on the site include the following:

> *Construction, including the delivery of materials to and from the site, may only be carried out*
> *between the following hours:*
> *(a) between 7am and 6pm, Mondays to Fridays inclusive; and*
> *(b) between 8am and 4pm, Saturdays.*
> *No work may be carried out on Sundays or public holidays.*

8.1 Proposed Appliances

The proposed appliances which will be used as part of the excavation required as part of the development are detailed in the table below:

Table 9 – Noise Level from Expected Demotion Appliances

Tasks	Equipment	Sound Power Levels per task dB(A) L_{10}	Aggregate Sound Power Level per Task dB(A) L_{10}
Site Excavation works	Jack hammer mounted on skid steer	118	124
	Hydraulic Hammering	120	
	Hand held jack hammer	111	
	Concrete saw	119	
	Skid steer	110	
	Power hand tools	109	
Construction Works	Piling	115	120
	Welder	101	
	Saw cutter	109	
	Dump truck	109	
	Concrete saw	119	
	Power hand tools	109	
	Cranes	110	

Notes: Noise levels of proposed equipment to be used on the site based on the Australian Standard AS2436-2010 and noise level measurements previously undertaken of similar equipment on construction sites.

8.2 Construction Noise Criteria

This section of the report details the relevant construction noise criteria which is applicable to the site.

8.2.1 Interim Construction Noise Guideline

Noise criteria for construction and excavation activities are discussed in the *Interim Construction Noise Guideline* (ICNG). The ICNG also recommends procedures to address potential impacts of construction noise on residences and other sensitive land uses. The main objectives of the ICNG are summarised as follows:

- Promote a clear understanding of ways to identify and minimise noise from construction works;
- Focus on applying all “feasible” and “reasonable” work practices to minimise construction noise impacts;
- Encourage construction to be undertaken only during the recommended standard hours unless approval is given for works that cannot be undertaken during these hours;
- Streamline the assessment and approval phases and reduce time spent dealing with complaints at the project implementation phase; and

- Provide flexibility in selecting site-specific feasible and reasonable work practices in order to minimise noise impacts.

The ICNG contains a quantitative assessment method which is applicable to this project. Guidance levels are given for airborne noise at residences and other sensitive land uses.
The quantitative assessment method involves predicting noise levels at sensitive receivers and comparing them with the Noise Management Levels (NMLs). The NML affectation categories for receivers have been reproduced from the guideline and are listed in the table below.

Table 10 – Noise Management Levels from Construction – Quantitative Assessment

Receiver Type	Time of Day	Noise Management Level LAeq(15minute)1,2	How to Apply
Residential	Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq(15minute) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
		Highly noise affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences. 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
	Outside recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Table 10 – Continued

Receiver Type	Time of Day	Noise Management Level LAeq(15minute)1,2	How to Apply
offices, retail outlets: external	When is use	LAeq (15 min) 70 dB(A)	During construction, the proponent should regularly update the occupants of the commercial and industrial premises regarding noise levels and hours of work.

Note 1 *Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.*

Note 2 *The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy (EPA 2000).*

Based on the table above the suitable construction noise management levels for works undertaken on the site is detailed in Table 10 below.

Table 11 – Site Construction Noise Management Levels

Noise Source	Time Period	Receiver Type	Construction Noise Management Level	'High Noise Affected' Level
Construction Noise	Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Residential	53 dB(A) $L_{Aeq\ (15min)}$	75 dB(A) $L_{Aeq\ (15min)}$
		Commercial	-	70 dB(A) $L_{Aeq\ (15min)}$
	When in Use	Schools, internally	45 dB(A) $L_{eq\ (15\ min)}$	

Note 1: Construction noise management levels based on the Interim Construction Noise Guideline

8.3 Construction Vibration Criteria

Effects of ground borne vibration on buildings may be segregated into the following three categories:

- Human comfort – vibration in which the occupants or users of the building are inconvenienced or possibly disturbed. Refer to further discussion in Section 7.3.1.
- Effects on building contents – where vibration can cause damage to fixtures, fittings and other non-building related objects. Refer to further discussion in Section 7.3.2 and 7.3.3.
- Effects on building structures – where vibration can compromise the integrity of the building or structure itself. Refer to further discussion in Section 7.3.2 and 7.3.3.

8.3.1 Vibration Criteria – Human Comfort

Vibration effects relating specifically to the human comfort aspects of the project are taken from the guideline titled *"Assessing Vibration – A Technical Guideline"*. (AVTG) This type of impact can be further categorised and assessed using the appropriate criterion as follows:

- Continuous vibration – from uninterrupted sources (refer to Table 12).
- Impulsive vibration – up to three instances of sudden impact e.g. dropping heavy items, per monitoring period (refer to Table 13).
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously (refer to Table 14).

Table 12 - Continuous vibration acceleration criteria (m/s2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night-time	0.020	0.014	0.040	0.028
		0.04	0.029	0.080	0.058
Workshops	Day or night-time	0.04	0.029	0.080	0.058

Table 13 - Impulsive vibration acceleration criteria (m/s2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night-time	0.64	0.46	1.28	0.92
Workshops	Day or night-time	0.64	0.46	1.28	0.92

Table 14 - Intermittent vibration impacts criteria (m/s1.75) 1 Hz-80 Hz

Location	Daytime		Night-time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

8.3.2 Vibration Criteria – Building Contents and Structure

The vibration effects on the building itself are assessed against international standards as follows:

- For transient vibration: British Standard BS 7385: Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration" (BSI 1993); and
- For continuous or repetitive vibration: German DIN 4150: Part 3 – 1999 "Effects of Vibration on Structure" (DIN 1999).

8.3.3 Standard BS 7385 Part 2 - 1993

For transient vibration, as discussed in standard BS 7385 Part 2-1993, the criteria are based on peak particle velocity (mm/s) which is to be measured at the base of the building. These are summarised in Table 15 and illustrated in the Figure below.

Table 15 - Transient vibration criteria as per standard BS 7385 Part 2 - 1993

Line in Figure below	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Standard BS 7385 Part 2 – 1993 states that the values in Table 15 relate to transient vibration which does not cause resonant responses in buildings. Where the dynamic loading caused by continuous vibration events is such as that results in dynamic magnification due to resonance (especially at the lower frequencies where lower guide values apply), then the values in Table 15 may need to be reduced by up to 50% (refer to Line 3 in the Figure below).

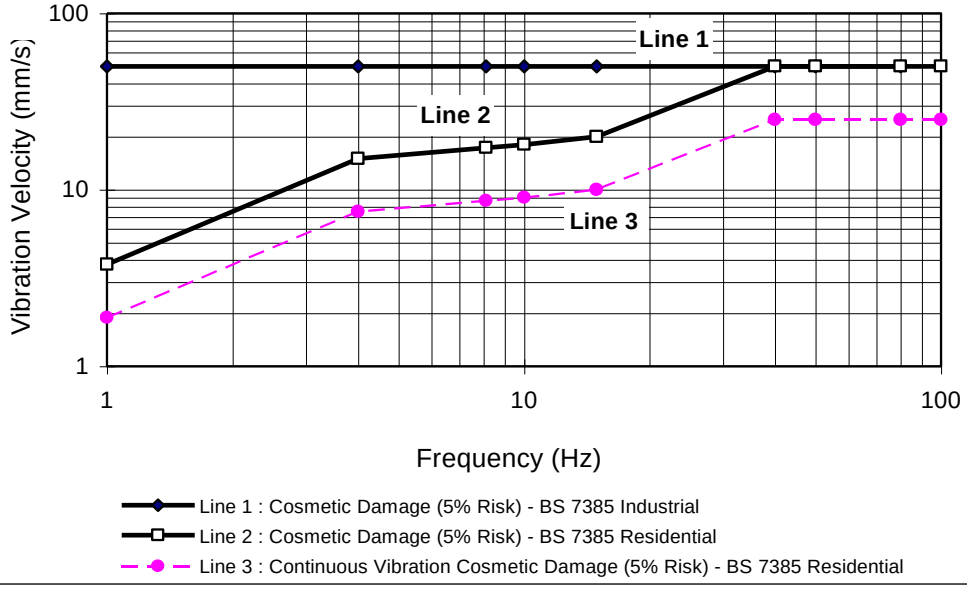


Figure 5 - BS 7385 Part 2 – 1993, graph of transient vibration values for cosmetic damage

In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the recommended values corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.
The standard also states that minor damage is possible at vibration magnitudes which are greater than twice those given in Table 15, and major damage to a building structure may occur at values greater than four times the tabulated values.
Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the values in Table 15 should not be reduced for fatigue considerations.

8.3.3.1 Standard DIN 4150 Part 3 - 1999

For continuous or repetitive vibration, standard DIN 4150 Part 3-1999 provides criteria based on values for peak particle velocity (mm/s) measured at the foundation of the building; these are summarised in Table 16. The criteria are frequency dependent and specific to particular categories of structures.

Table 16 - Structural damage criteria as per standard DIN 4150 Part 3 - 1999

Type of Structure	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]	
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Note 1: For frequencies above 100Hz, at least the values specified in this column shall be applied.

8.4 Construction Vibration Management

An assessment of the potential for vibration generated as part of the required construction activities on the project (including excavation and construction) has been undertaken.

As the proposed development does not include demolition of existing buildings and the proximity of neighbouring structures to the development site (which including residential receives and the existing Macquarie University Sports and Aquatic Centre) vibration levels generated from the proposed excavation and construction on the site are expected to comply with all vibration criteria detailed in this report.

In the event excavation is required on the site including removal of stone, the following management technique should be included in the excavation methodology:

- A saw cut at the perimeter of any excavation within rock on the excavation boundary adjacent neighbouring buildings and with a distance of less than 25m then is it required to include a saw cut to the rock prior to use of any excavation or ripping.

8.5 Construction Noise Management – Qualitative Assessment

Based on the assessment conducted of the expected construction noise levels generated from the RIDBC Centre of Excellence site noise levels are generally expected to require the building contractor to engage in management of activities on the site and engagement with the local community.

Notwithstanding, the following management controls are recommended to mitigate construction noise levels on the site:

1. All plant and equipment are to be maintained such that they are in good working order.
2. A register of complaints is to be recorded in the event of complaints being received, including location, time of complaint, nature of the complaint and actions resulting from the complaint.
3. If required a noise level measurement of the offending plant item generating complaints is to be conducted and noise mitigations undertaken to reduce noise levels to within Noise Management levels in the event magnitude of noise levels is found to be above suitable levels.
4. The use of percussive and concrete sawing should be undertaken behind a closed façade when possible.
5. The use of high noise generating equipment including hydraulic hammers, rock cutters or the like should not be undertaken prior to 8am Monday to Friday or 8.30am Saturdays.
6. The loading of trucks should be conducted such that there is not a requirement to stack truck on the roadways adjacent to the residence within the Macquarie University Village.
7. Where possible to use of squawkers or the like should be used in place of reversing alarms.

In addition to the recommended mitigations above details of the proposed construction (including excavation) works to be conducted on the site, including type of activities to be conducted as well as the expected duration of activities, should be provided to the neighbouring receivers.

A detailed construction noise and vibration management plan is to be provided by the building contractor.

8.6 Construction Noise Assessment – Quantitative Assessment

A quantitative assessment of the construction noise levels resulting from the proposed works to be undertaken as part of the RIDBC Centre of Excellence project on surrounding residential receivers has been undertaken.

The assessment has been based on the expected noise levels to be generated on the site including those detailed in Section 8.2 above. Calculations of the resulting construction noise levels of the residential receivers within proximity to the site is detailed in the table below.

Table 17 - Quantitative Assessment of Construction Noise to Neighboring Residence

Source Noise	Equipment	Sound Power Levels dB(A) L_{10}	Aggregate Sound Power Level dB(A) L_{10}	Calculated Construction Noise Level – Macquarie University Village
Site Excavation works	Jack hammer mounted on skid steer	118	124	Up to 75 dB(A) when items used externally
	Hand held jack hammer	111		
	Concrete saw	119		
	Skid steer	110		
	Power hand tools	109		
Construction Works	Piling	115	120	Up to 73 dB(A) when items used externally
	Welder	101		
	Saw cutter	109		
	Dump truck	109		
	Concrete saw	119		
	Power hand tools	109		
	Cranes	110		

Based on the qualitative assessment of construction noise suitable management controls and community notifications are required to be conducted.

The required management of construction noise impacts are included in Section 8.4 above.

8.7 Noise and Vibration Monitoring

As part of the management of noise from the proposed excavation and construction activities to be undertaken on the site the following noise and vibration measurements are recommended to be undertaken:

1. Noise – Attended noise level measurements of typical excavation and construction activities should be undertaken at site.

   Attended construction noise surveys of the site and surrounding impacts on neighbours should be undertaken during the following as a minimum:
   a. Commencement of any rock breaking or sawing on the site.
   b. In response to any ongoing complaints received from neighbours.

2. Vibration – Based on the proximity of the surrounding receivers to the works attended vibration measurements of typical excavation and construction activities should be undertaken at site.

   Attended construction vibration measurements at representative locations to the neighbouring building structures should be undertaken at the following times as a minimum:
   a. Commencement of any rock breaking or sawing on the site required to be conducted within rock during the excavation stage of the project.
   b. In response to any ongoing complaints received from neighbours.

9 Conclusion

This report details the Noise Impact Assessment of the proposed RIDBC Centre of Excellence at Macquarie University project.

Based on the results of this assessment noise levels associated with the future operation of the project, including the proposed outdoor play areas, future drop off area, mechanical plant and equipment and internal areas of the project will be ascetically acceptable.

This assessment has completed the required investigations, and compliance requirements including those of the EPA Noise Policy for Industry and Road Noise Policy.

Providing the recommended treatments and controls detailed in this report are included in the design and operation of the RIDBC Centre of Excellence at Macquarie University noise emissions from the site will be acoustically acceptable at all surrounding receivers, including the residential the Macquarie University Village.

Additionally, noise and vibration generated during the proposed construction period of the project (including excavation activities) can be suitably managed in accordance with the EPA's Interim Construction Noise Guideline.

For any additional information please do not hesitate to contact the person below.

Regards

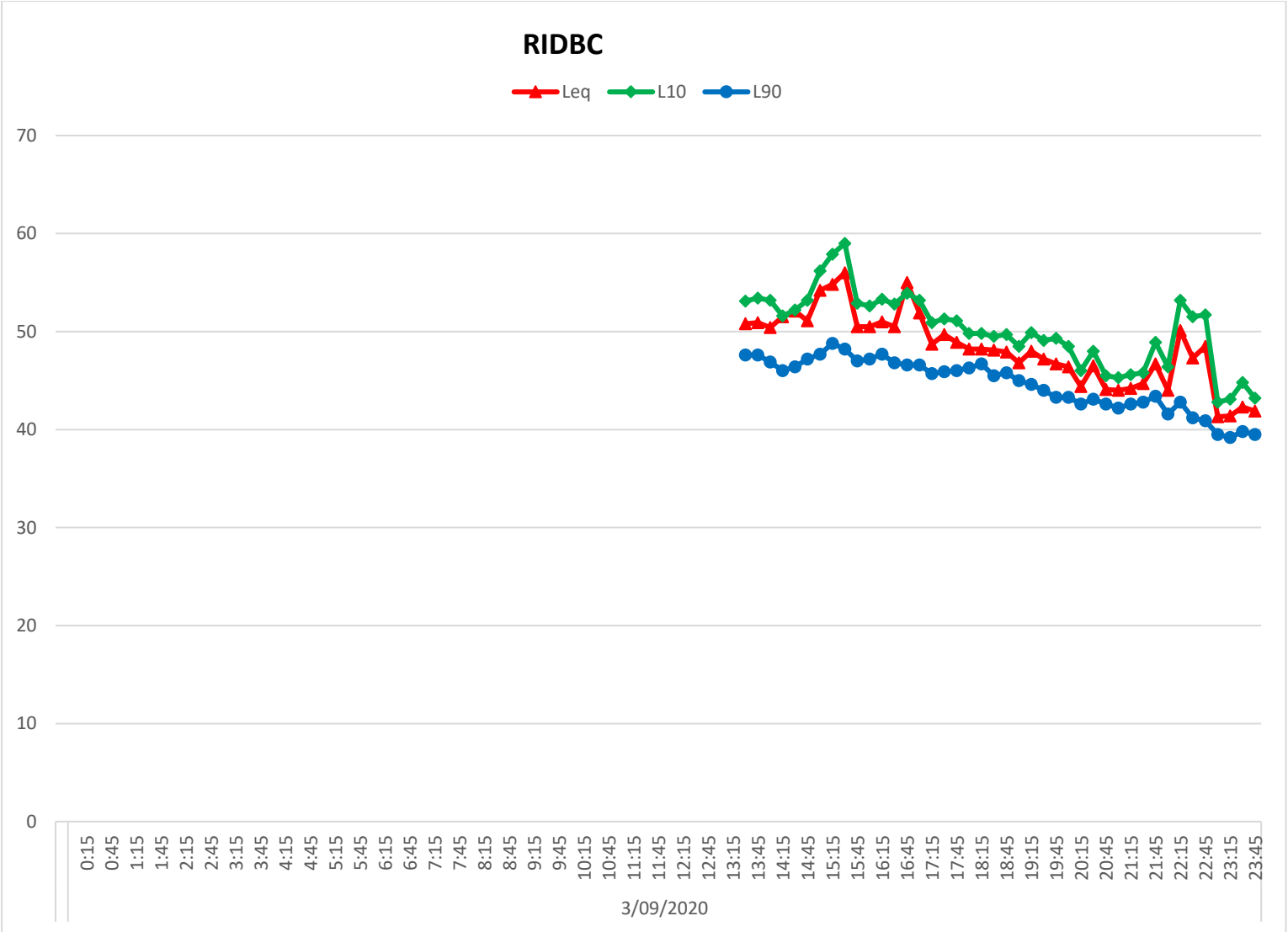
Ben White
Director
White Noise Acoustics

10 Appendix A – Glossary of Terms

Ambient Sound	The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
Character, acoustic	The total of the qualities making up the individuality of the noise. The pitch or shape of a sound's frequency content (spectrum) dictate a sound's character.
Decibel [dB]	The level of noise is measured objectively using a Sound Level Meter. The following are examples of the decibel readings of every day sounds; 0dB the faintest sound we can hear 30dB a quiet library or in a quiet location in the country 45dB typical office space. Ambience in the city at night 60dB Martin Place at lunch time 70dB the sound of a car passing on the street 80dB loud music played at home 90dB the sound of a truck passing on the street 100dB the sound of a rock band 115dB limit of sound permitted in industry 120dB deafening
dB(A)	*A-weighted decibels* The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise.
Frequency	Frequency is synonymous to *pitch*. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Background Sound Low	The average of the lowest levels of the sound levels measured in an affected area in the absence of noise from occupants and from unwanted, external ambient noise sources. Usually taken to mean the L_{A90} value
Ctr	A frequency adaptation term applied in accordance with the procedures described in ISO 717.

dB (A)	'A' Weighted overall sound pressure level
Noise Reduction	The difference in sound pressure level between any two areas. The term "noise reduction" does not specify any grade or performance quality unless accompanied by a specification of the units and conditions under which the units shall apply
NR Noise Rating	Single number evaluation of the background noise level. The NR level is normally around 5 to 6 dB below the "A" weighted noise level. The NR curve describes a spectrum of noise levels and is categorised by the level at 1000 Hz ie the NR 50 curve has a value of 50 dB at 1000 Hz. The NR rating is a tangential system where a noise spectrum is classified by the NR curve that just encompasses the entire noise spectrum consideration.
R_w	Weighted Sound Reduction Index - Laboratory test measurement procedure that provides a single number indication of the acoustic performance of a partition or single element. Calculation procedures for Rw are defined in ISO 140-2:1991 "Measurement of Sound Insulation in Buildings and of Building Elements Part 2: Determination, verification and application of precision data".
R'_w	Field obtained Weighted Sound Reduction Index - this figure is generally up to 3-5 lower than the laboratory test determined level data due to flanked sound transmission and imperfect site construction.
Sound Isolation	A reference to the degree of acoustical separation between any two areas. Sound isolation may refer to sound transmission loss of a partition or to noise reduction from any unwanted noise source. The term "sound isolation" does not specify any grade or performance quality and requires the units to be specified for any contractual condition
Sound Pressure Level, L_P dB	A measurement obtained directly using a microphone and sound level meter. Sound pressure level varies with distance from a source and with changes to the measuring environment. Sound pressure level equals 20 times the logarithm to the base 10 of the ratio of the rms sound pressure to the reference sound pressure of 20 micro Pascals.
Sound Power Level, L_W dB	Sound power level is a measure of the sound energy emitted by a source, does not change with distance, and cannot be directly measured. Sound power level of a machine may vary depending on the actual operating load and is calculated from sound pressure level measurements with appropriate corrections for distance and/or environmental conditions. Sound power levels is equal to 10 times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 picoWatt
Speech Privacy	A non-technical term but one of common usage. Speech privacy and speech intelligibility are opposites and a high level of speech privacy means a low level of speech intelligibility. It should be recognised that acceptable levels of speech privacy do not require that speech from an adjacent room is inaudible.
Transmission Loss	Equivalent to Sound Transmission Loss and to Sound Reduction Index in terminology used in countries other than Australia. A formal test rating of sound transmission properties of any construction, by usually a wall, floor, roof etc. The transmission loss of all materials varies with frequency and may be determined by either laboratory or field tests. Australian Standards apply to test methods for both situations.

11 Appendix B – Noise Logging Results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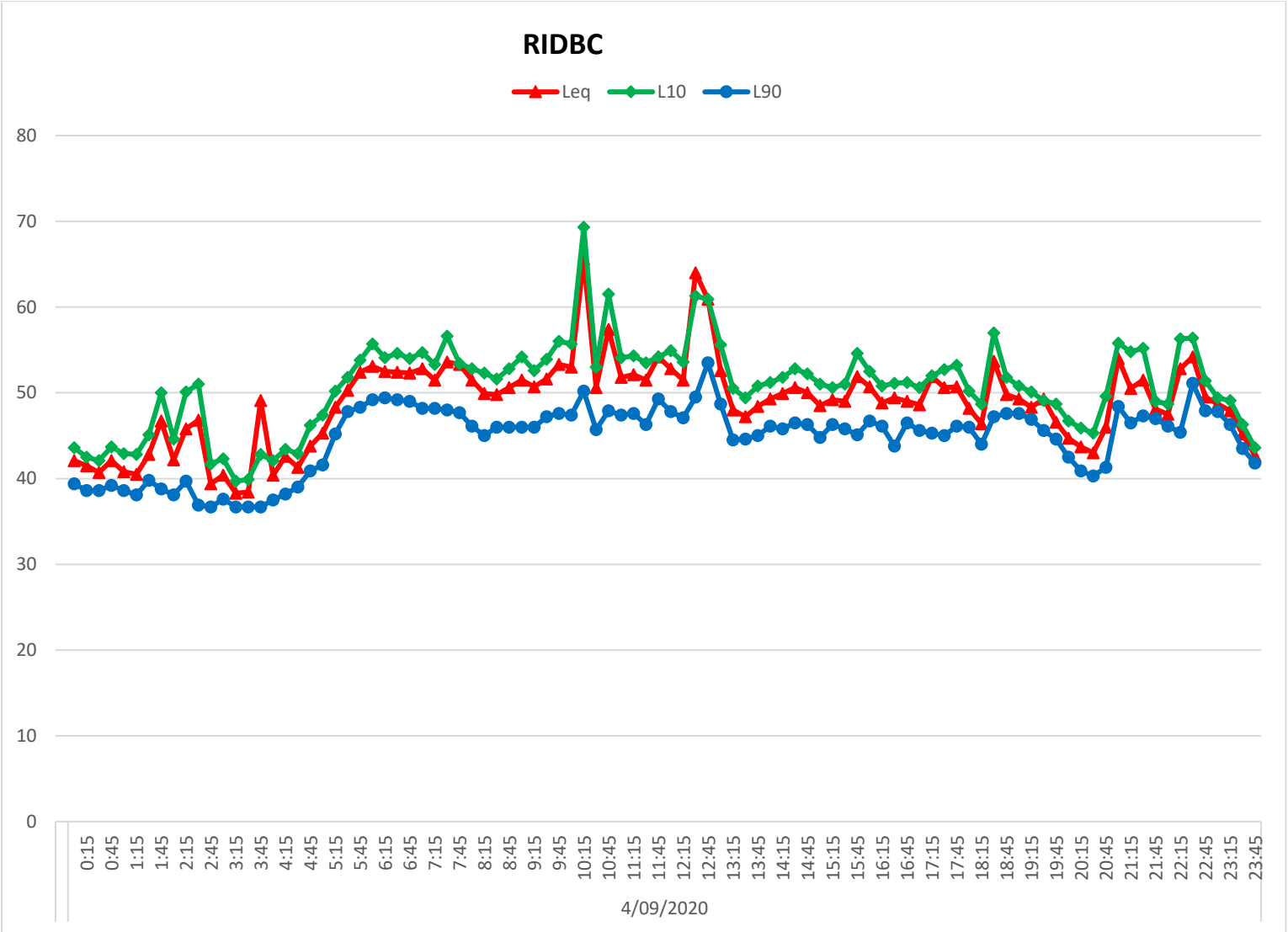
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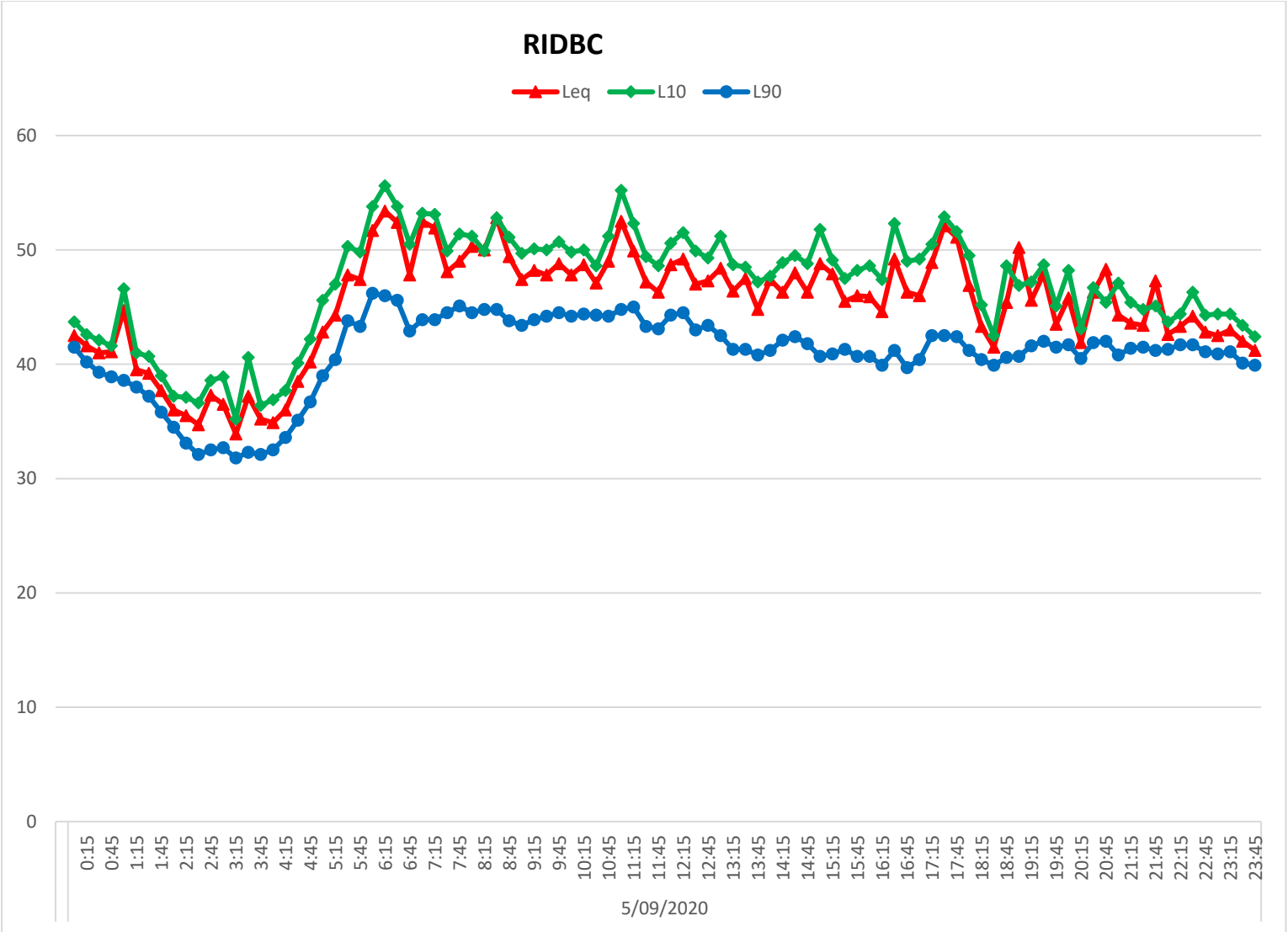
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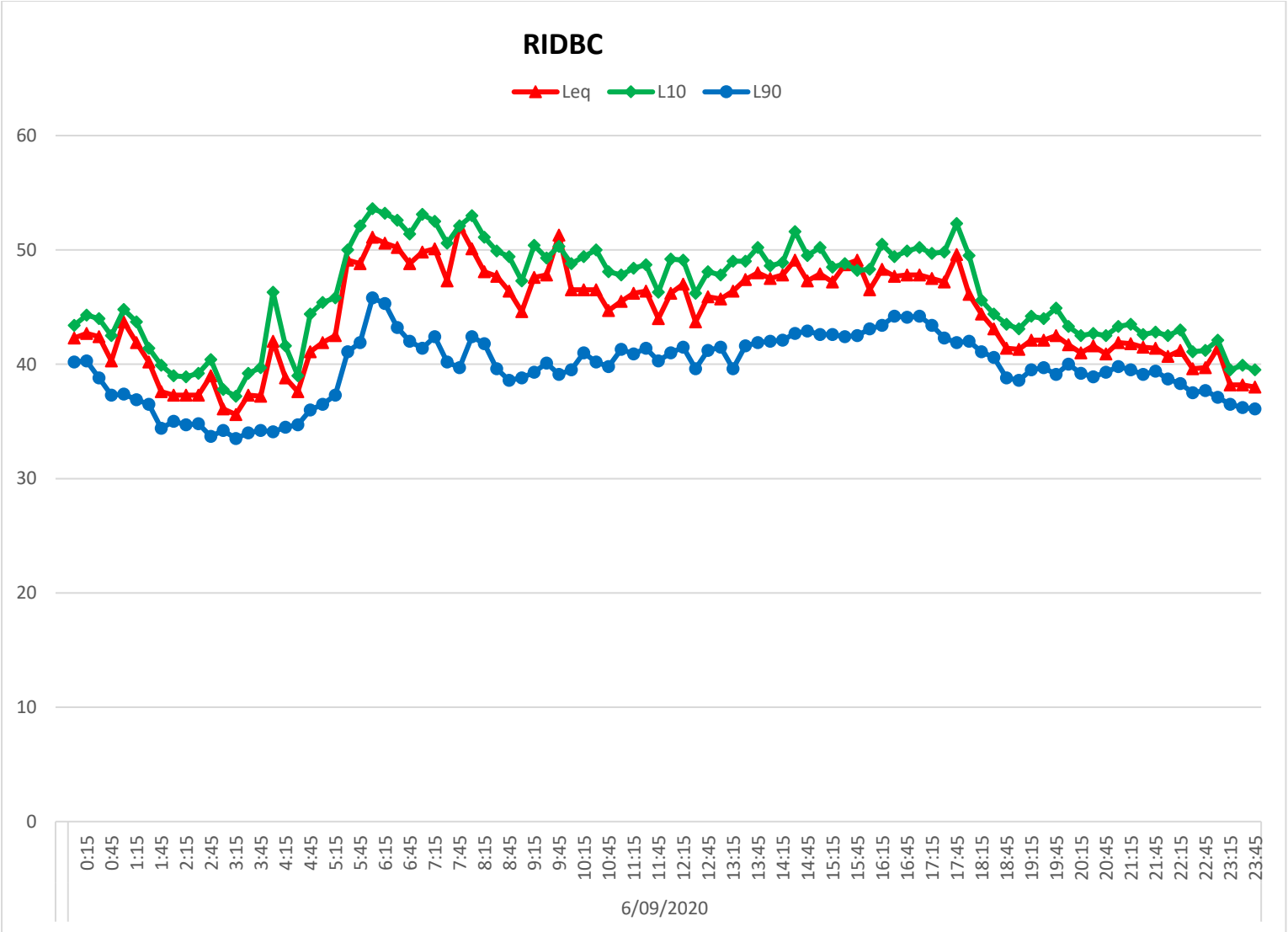
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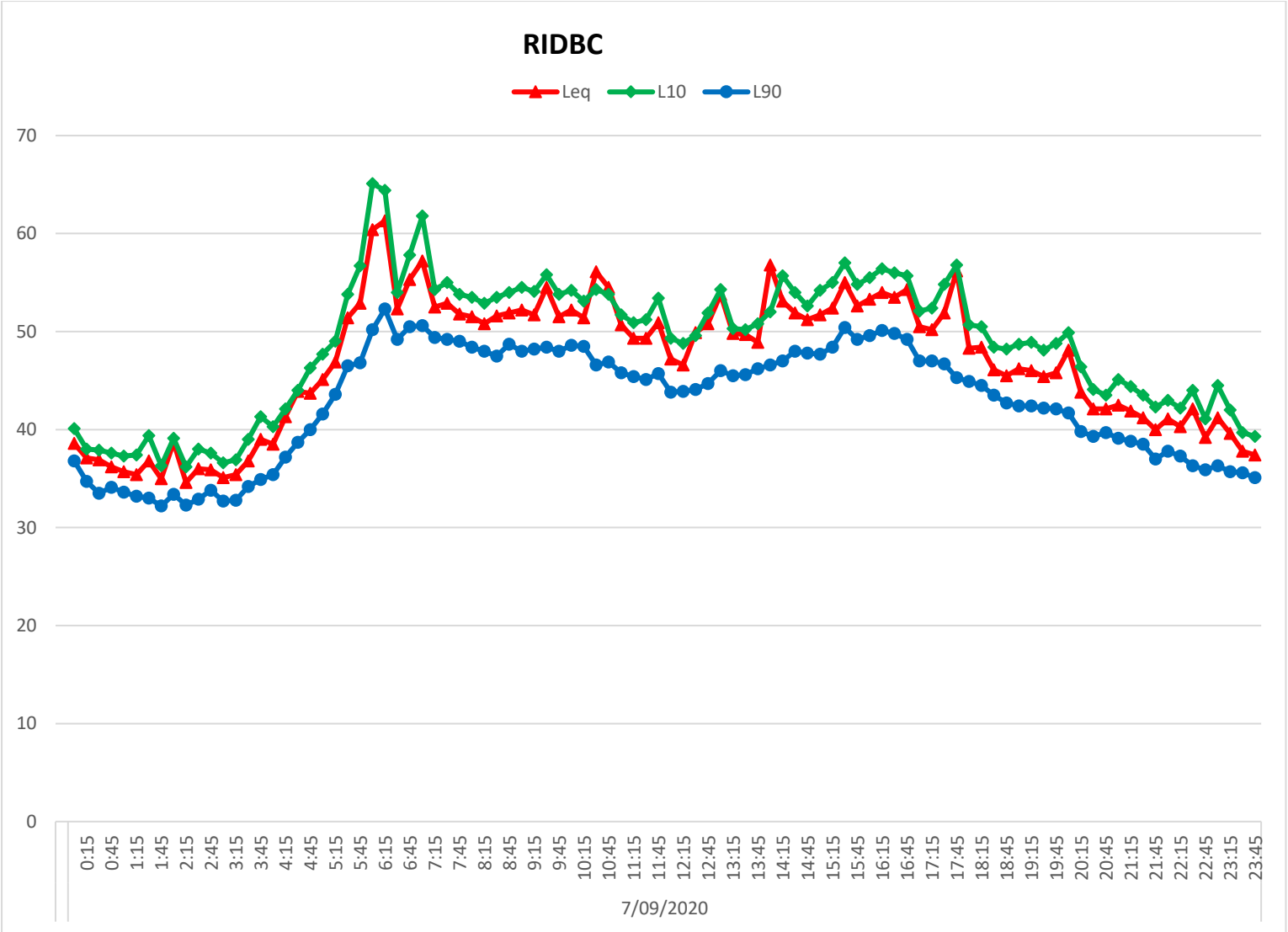
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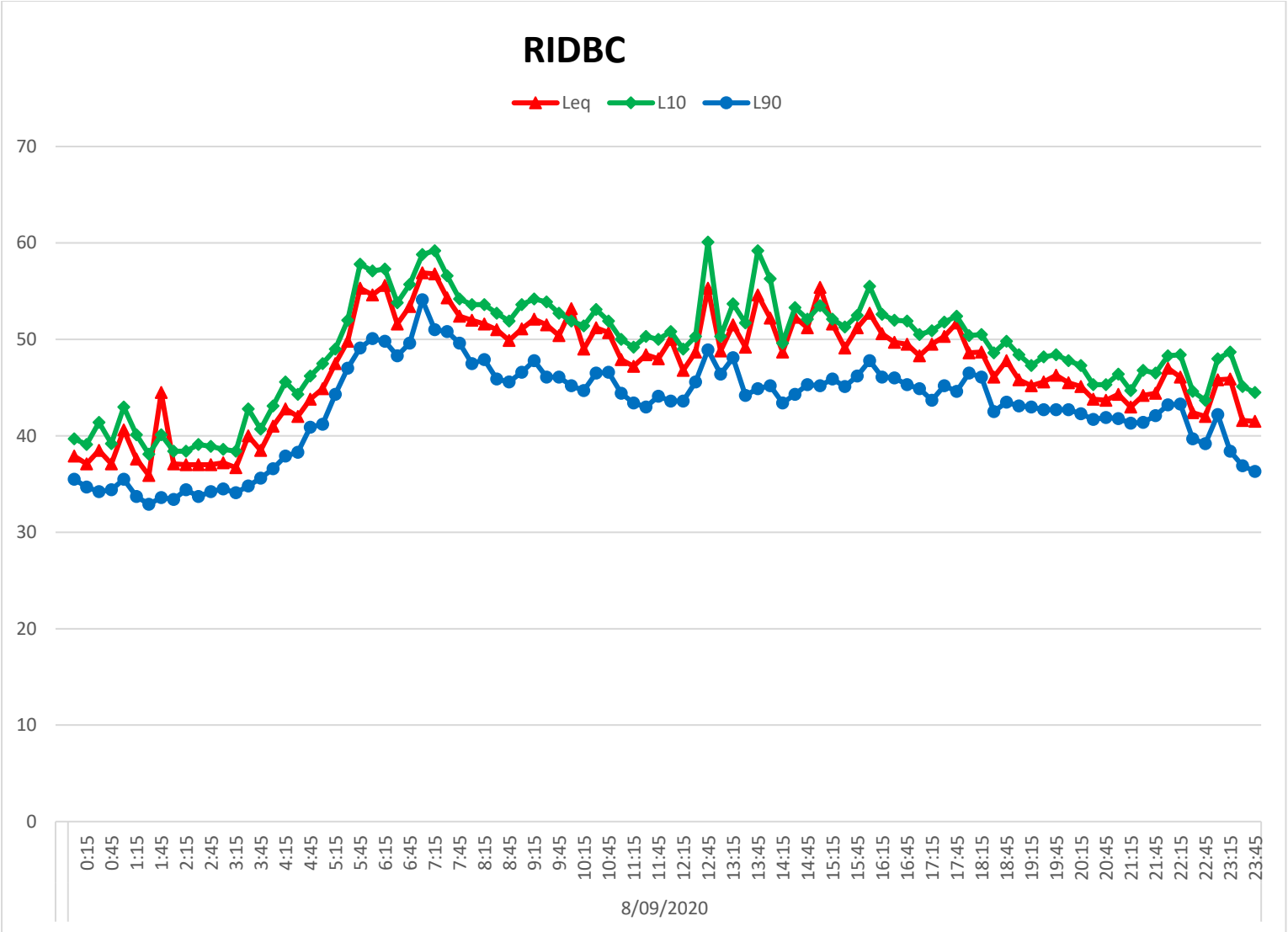
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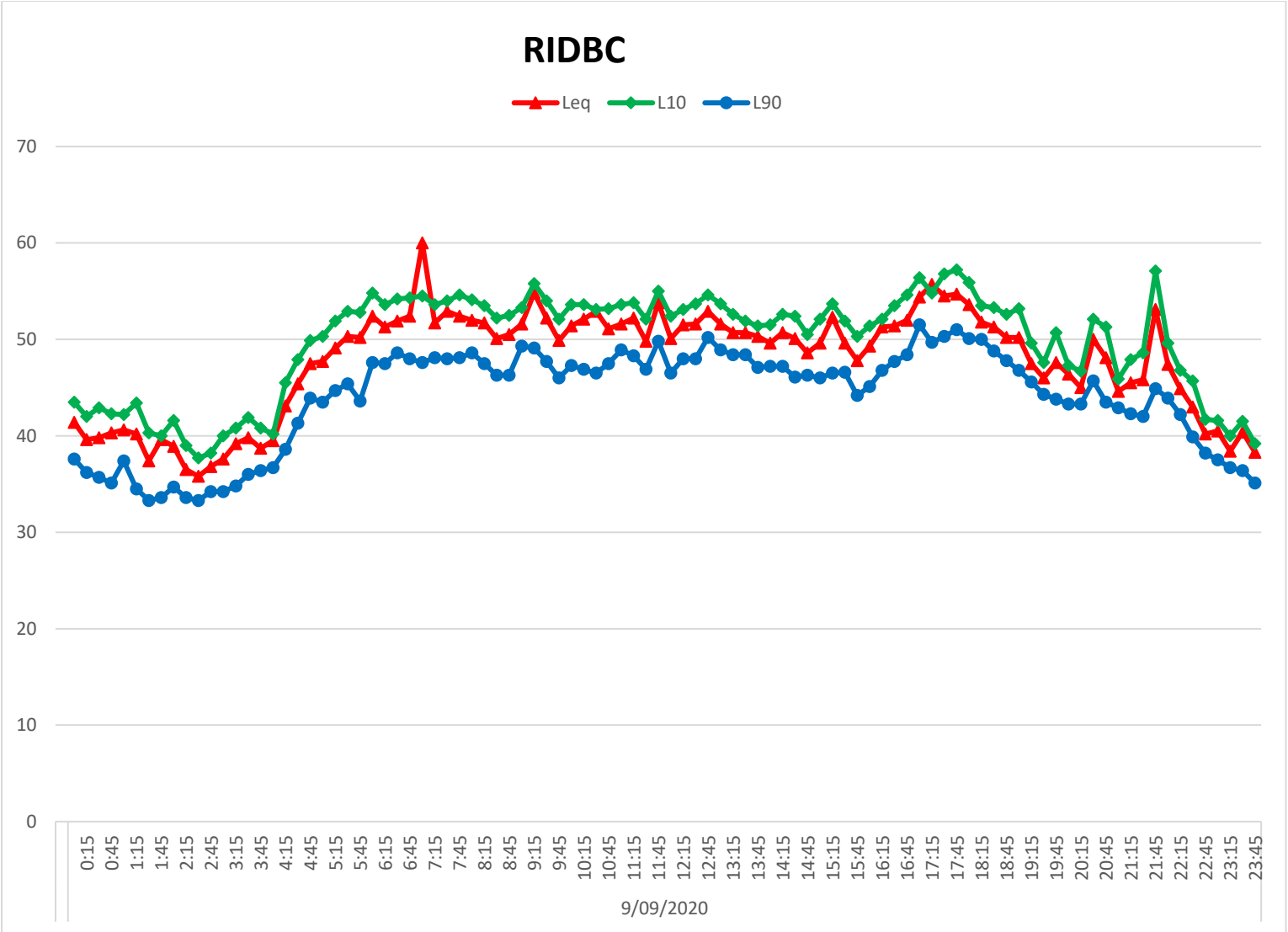
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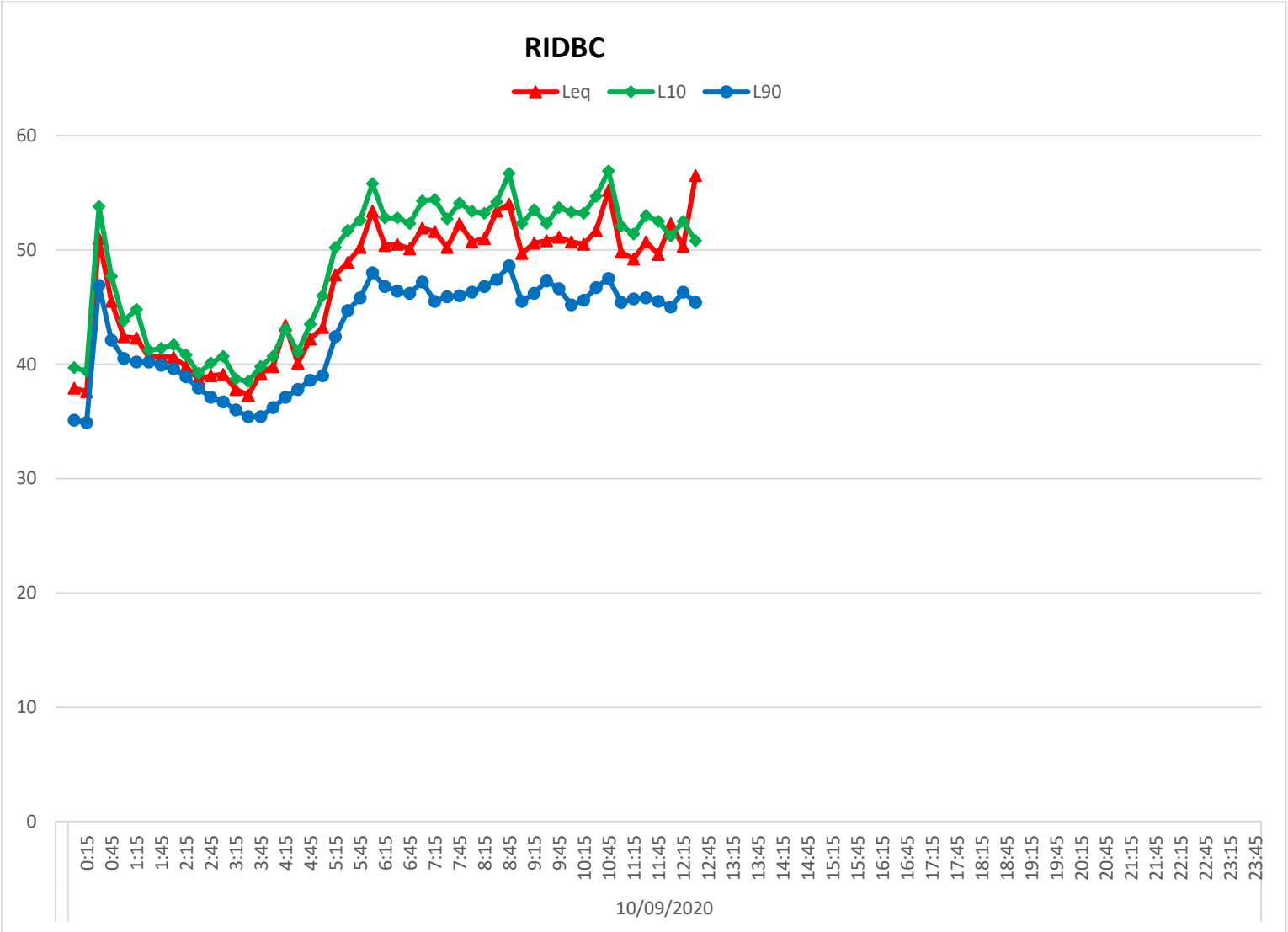
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