Moorebank Precinct West Stage 2 Proposal

Response to Submissions

Appendix D: Noise & Vibration supplementary response material

SIMTA

SYDNEY INTERMODAL TERMINAL ALLIANCE

Part 4, Division 4.1, State Significant Development

June 2017

25 May 2017

WM Project Number: 15324
Our Ref: 15324 Ltr 170317

Westley Owers
Arcadis
Level 5 141 Walker Street
NORTH SYDNEY NSW 2060

Dear Westley

Re: MPW Stage 2 - RtS Technical Memo

This technical memo has been prepared to support responses to submissions (RtS) to the Environmental Impact Statement (EIS) for the Moorebank Precinct West (MPW) Stage 2 Proposal (the Proposal), in relation to noise and vibration. These submissions are summarised as follows:

- Submission from the NSW Environment Protection Authority (EPA) regarding the existing levels of rail noise at sensitive receivers near the Proposal, and the subsequent assessment of increases in rail noise due to the Proposal;
- Submission from EPA regarding sleep disturbance impacts due to rail movements associated with the Proposal; and,
- Submissions from Liverpool City Council and Moorebank Heritage Group regarding vibration impacts, particularly at heritage buildings.

This technical memo should be read in conjunction with the following documents:

- Noise and Vibration Impact Assessment (NVIA) for the Proposal, prepared by Wilkinson Murray (Report No. 15324 VerA_Final, provided at Appendix M of the EIS).
- NVIA for the Amended Proposal, as part of the MPW Stage 2 response to submissions report (Report No. 15324 VerD_Final, provided at Appendix D of the response to submissions report).

RAIL NOISE

Submissions

During the exhibition of the EIS, submissions were made regarding the assessment of rail noise from the Proposal by the NSW Environment Protection Authority (EPA). In particular, submissions requested more information relating to the quantification of existing levels of rail noise at the most potentially affected residential receivers, and further justification / demonstration that the Proposal would not noticeably increase rail noise at these location. An Excerpt from the submissiond received from the EPA on the Proposal, as they relate to rail noise have been provided in Table 1.

Table 1 Submissions Relating to Existing Rail Noise Levels

Agency	Submission
EPA	The expected increase in rail noise due to the project should be quantified using rail noise levels measured or predicted at the same point as used to predict the rail noise level for the project, using the same parameter. The assessment used the LAeq(24hour) 48.4 dBA rail noise level predicted for year 2020 at 77 Leacocks Lane, Casula, in the Southern Sydney Freight Line Operational Noise and Vibration Management Plan (Appendix B of the Operational Environmental Management Plan), to suggest that the project's rail movements would increase LAeq(period) rail noise levels by less than 2 dB at Lot 21 Leacocks Lane, the closest receiver in the area. The assessment relied on some optimistic assumptions: • The assessment stated that existing rail noise levels at Lot 21 Leacocks Lane were 3 to 5 dBA above those at 77 Leacocks Lane, because Lot 21 Leacocks Lane had direct line of sight to the Southern Sydney Freight Line and 77 Leacocks Lane does not. The 3 to 5 dBA appears to be a subjective estimate rather than being based on modelling. • Rail noise levels in the area will not change significantly between now and 2020. • The LAeq (24hour) predicted in the Southern Sydney Freight Line plan is equivalent to the LAeq (night) predicted in the assessment. The expected increase in rail noise due to the project should be quantified using rail noise levels measured or predicted at the same point as used to predict the rail noise level for the project, using the same parameter. The method used to estimate rail noise increase in the assessment was highly subjective and reliant on assumptions which were not adequately explained.

To respond to these issues raised during the exhibition of the EIS, additional monitoring of existing rail noise levels and assessment of the potential impacts of the Proposal on noise sensitive receivers have been undertaken. This section of the memo describes the methodology and results of these additional investigations, and provides a discussion / validation of the potential operational noise impacts in light of these additional investigations.

Rail noise criteria

As detailed in Section 6.4 of the NVIA (Appendix N of the EIS), airborne noise from freight rail movements along the Rail Link have been assessed using the Rail Infrastructure Noise Guideline (RING) (EPA, 2013). In accordance with RING, the section of the Rail link between the Southern Sydney Freight Line (SSFL) and the Proposal site is classified as a 'non-network line servicing an industrial site'.

The relevant rail noise criteria for the assessment of potential impacts from the Rail link between the Proposal site and the SSFL are summarised in Table 2 below.

Table 2 Rail Noise L_{Aeq} Criteria

Receiver	Indicative Noise Amenity Criteria	Time Period[1]	$L_{Aeq, period}$ Criteria
Casula Glenfield Wattle Grove	Residential Suburban	Day	55
		Evening	45
		Night	40
S1, S2	School/ classroom	Noisiest 1-hour period when in use	45
I1, I2, I3	Industrial	When in use	70

1. Daytime 7:00am–6:00pm; Evening 6:00pm–10:00pm; Night 10:00pm-7:00am.

It should be noted that the rail noise criteria presented in Table 2 are applicable only to rail noise levels at sensitive receivers due to rail movements on the Rail link. These criteria are not applicable to existing rail noise levels at sensitive receivers due to rail movements on nearby network rail lines, such as the Main Southern Line and the SSFL. Moreover, RING does not provide guidance on how to assess the total levels of rail noise at sensitive receivers due to the combined operation of network and non-network rail lines.

Methodology

To provide a clearer indication of the potential impact of the Proposal on L_{Aeq} rail noise levels at sensitive receivers the assessment presented in the NIVA at Appendix N of the Proposal has been revised. This involved a more robust estimation of rail noise levels at sensitive receivers without the Proposal, and also removing some of the conservatism of the previous assessment.

To respond to the issues raised by the EPA, the following was undertaken:

- Correction of predicted noise levels at noise sensitive receivers by calibrating L_{Aeq} noise levels in the model using the logarithmic average (in lieu of the 95th percentile) of the measured noise levels from the Transport for New South Wales (TfNSW) Rail Noise Database;
- Additional monitoring of existing rail noise levels at nearby noise sensitive receivers, where the revised predicted L_{Aeq} rail noise levels exceed the relevant RING criteria;
- Establishment of rail noise levels at nearby noise sensitive receivers under the 'without the Proposal' (i.e. no build) scenario for the year of opening of the Proposal; and,
- Validation of likely increases in rail noise from the Proposal on nearby noise sensitive receivers.

Correction of predicted noise levels at noise sensitive receivers

The model used to predict rail noise levels at sensitive receivers in the NVIA was calibrated using the 95th percentile measured levels for freight locomotives and wagons from the TfNSW rail noise database. This is a very conservative measure, and typically, noise models used to predict L_{Aeq} noise levels are calibrated using the logarithmic average of the measured levels. As presented in the accompanying report to Version 3 of the TfNSW rail noise database, prepared by SLR Consulting, 95th percentile energy-based noise levels are 5 dBA higher than the logarithmic average noise levels for locomotives, and 4 dBA higher for freight wagons.

Therefore, to provide more reasonable predictions of L_{Aeq} rail noise levels from the Proposal, while still retaining a level of conservatism, the predicted L_{Aeq} rail noise levels presented in the NVIA for the EIS have been corrected downwards by 4 dBA.

A comparison of the predicted L_{Aeq} rail noise levels presented in Table 8-1 of the EIS with the corrected levels, are presented in Table 3.

The EIS results as presented in Table 3 indicate that the predicted $L_{Aeq,period}$ rail noise levels were originally predicted to exceed the relevant RING criteria for a private non-network line at the most affected residential receivers in Casula and Glenfield, and also at S1. The NVIA stated that, due to their proximity to the Main Southern Line, the East Hills Line and the Southern Sydney Freight Line (SSFL), the most affected residential receivers would most likely be subject to significant existing levels of rail noise. Further, it was concluded that the Proposal would be unlikely to result in a significant increase in the overall $L_{Aeq,period}$ rail noise levels.

The conclusions in the NVIA were supported with the best available data at the time on noise levels at sensitive receivers near the SSFL, and relied on a number of assumptions that were consistent and appropriate to the methodology used, but tended towards a conservative assessment of noise impact, i.e. and over-estimation of the existing and predicted noise levels, as detailed in the EPA's submissions in Table 1 above. The submissions received from government agencies during public exhibition have requested a more detailed assessment of existing L_{Aeq} rail noise levels in Casula and Glenfield.

Based on the corrected measurements provided in Table 3, the predicted $L_{Aeq,period}$ rail noise levels at nearby noise sensitive receivers, using the more appropriate logarithmic average of the measurement results in the TfNSW rail noise database, comply with the RING criteria for private non-network rail lines at all receivers, except Casula. Therefore, a more detailed assessment of L_{Aeq} rail noise levels in Casula is warranted, and requires that the existing levels of rail noise be established at this location only

Table 3 **Comparison of the Predicted L_{Aeq} Rail Noise Levels from the Proposal at Noise Sensitive Receivers – 95th Percentile vs Logarithmic Average**

Receiver	Predicted Level (dBA)						RING Criteria (Recommended)			Exceedance of RING criteria (dBA)					
	Day		Evening		Night		Day	Evening	Night	Day		Evening		Night	
	EIS	Corrected	EIS	Corrected	EIS	Corrected				EIS	Corrected	EIS	Corrected	EIS	Corrected
Casula	50	46	**50**	**46**	**48**	**44**	55	45	40	0	0	**5**	**1**	**8**	**4**
Glenfield	43	39	43	39	**41**	37	55	45	40	0	0	0	0	**1**	0
Wattle Grove	41	37	42	38	39	35	55	45	40	0	0	0	0	0	0
S1	**48**	44	**48**	44	**47**	43		45 (when in use)		0	0	**3**	0	**2**	0
S2	43	39	43	39	42	38		45 (when in use)		0	0		0	0	0

1.Daytime = 7.00am-6.00pm; Evening = 6.00pm-10.00pm; Night = 10.00pm-7.00am.

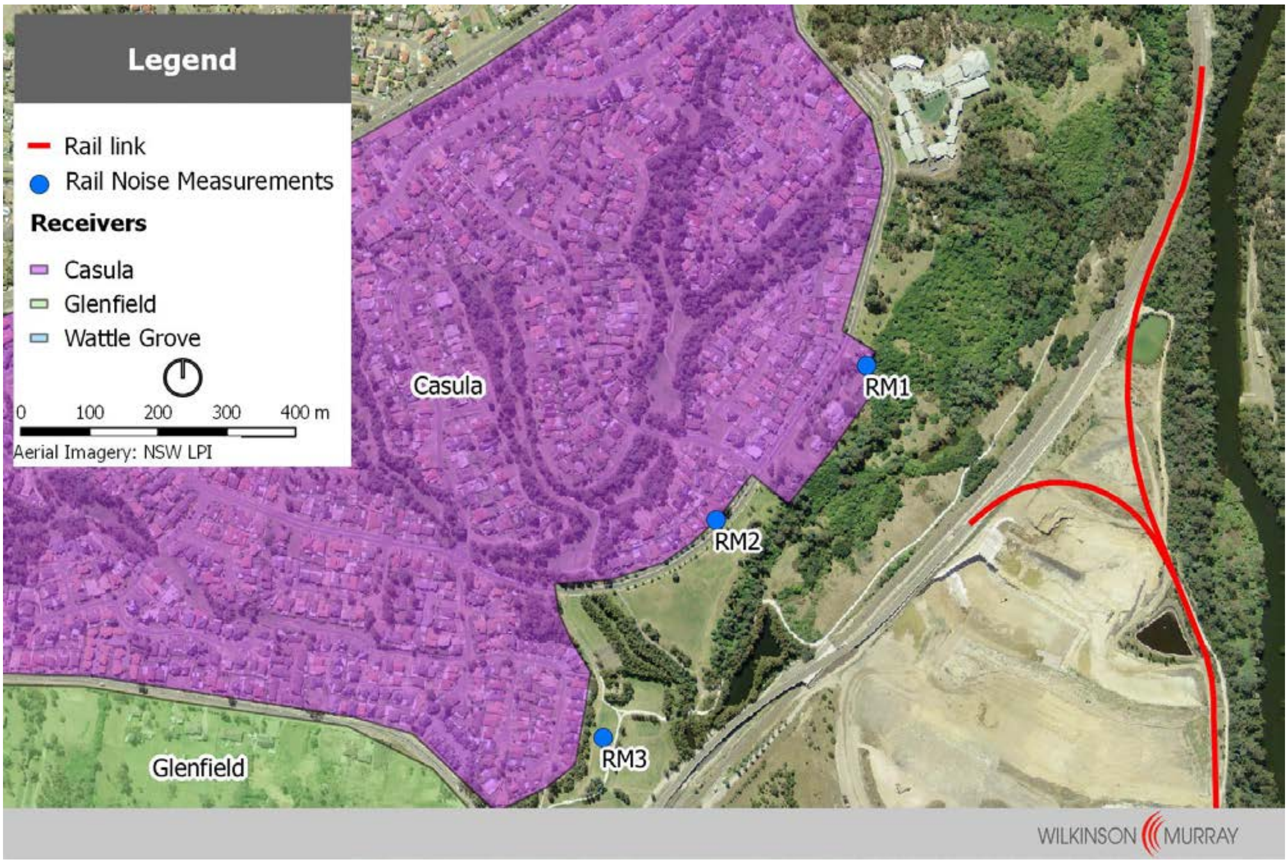
Rail Noise Monitoring

To establish the existing L_{Aeq} rail noise levels at the most affected residential receivers in Casula at the year of opening without the Proposal (herein referred to as the no-build scenario), attended noise monitoring was conducted at a number of locations near the connection of the Rail Link with the SSFL between 2 and 11 February 2017. Revised modelling results, presented in Table 3 of this technical memo, indicate that $L_{Aeq,period}$ noise levels from rail movements associated with the Proposal are only predicted to exceed the RING criteria in Casula. Therefore, rail noise monitoring has been confined to this area of interest.

Monitoring was undertaken at three locations, shown on Figure 1. The existing levels of rail noise will not be the same at all receivers in Casula, nor are the predicted rail noise levels from the Proposal. Therefore, the following monitoring locations were chosen to demonstrate the range of impacts at the most potentially affected receivers in Casula:

- RM1, which is representative of Glenfield Farm and adjacent residences along Leacocks Lane to the north of the intersection with Mackellar Street
- RM2, which is representative of residential receivers along Leacocks Lane to the south of the intersection with Mackellar Street
- RM3, which is representative of residential receivers on the eastern side of Slessor Road

Figure 1 Noise Monitoring Locations



At each monitoring location, attended noise measurements were conducted between approximately 10.00pm and 3.00am. During the attended monitoring, visual observations were made to identify freight and commuter rail movements, and a Sound Level Meter (SLM) and an environmental noise logger were used to measure noise levels from the observed rail movements. The noise logger captured 100ms data and high quality wave files to enable accurate and reliable post-processing of the measurement data to determine noise levels of the existing rail movements.

Following the noise monitoring, the 100ms and wave data were analysed to identify all freight and commuter movements, and to calculate the logarithmic average Sound Exposure Level (SEL) at each monitoring location for individual freight and commuter movements. The SEL noise descriptor represents the total acoustic energy for an event, normalised to a duration of 1 second, and is typically used to predict $L_{Aeq,period}$ noise levels for a given number of similar events over a particular period of time. On several occasions, multiple trains were audible at the same time. On these occasions, it was not possible to accurately determine the SEL for each movement, and these movements have not been included in the analysis.

Table 4 below provides a summary of the measured noise levels of freight and commuter passenger rail movements at the three noise monitoring locations. The measurement results for individual movements observed, measured and reliably analysed are presented in Appendix A of this memo.

Table 4 Summary of Measured Rail Noise from Freight and Passenger Rail Movements

Monitoring Location	Date	Freight		Commuter	
		No. of Measured Movements[1]	Log. Average SEL (dBA)	No. of Measured Movements[1]	Log. Average SEL (dBA)
RM1	9-10/02/2017	13	79.0	18	72.7
RM2	10-11/02/2017	5	75.1	34	62.0
RM3	2-3/02/2017	8	84.6	23	70.4

1. Total number of movements measured during monitoring period.

Establishment of rail noise levels under the ‘without Proposal’ (i.e. no-build) scenario for the year of opening of the Proposal

To estimate the levels of rail noise at the most affected residential receivers in Casula, during a typical day or night, for the no-build scenario, the logarithmic average SEL for freight and commuter rail movements as observed during the rail noise monitoring (refer to Table 4) have been combined with the projected rail movements for the year 2020, as presented in the *Southern Sydney Freight Line Operational Noise and Vibration Management Plan*, available on the ARTC website (www.artc.com.au/community/environment/). Where daily commuter rail movements are relatively constant, daily freight rail movements can vary considerably. Therefore, the SSFL projected volumes have been used to provide a reliable indication of typical daily rail movements in the area near the Proposal.

It is understood that the projected freight movements on the SSFL for 2020 as included in the SSFL operational noise and vibration management plan account for the rail movements associated with the Moorebank intermodal catchment demand, and would therefore, include the movements from the Proposal. Accordingly, for the purposes of estimating the levels of rail noise at sensitive receivers under the no-build scenario, the freight rail movements generated by the Proposal have been subtracted from the no-build scenario. The estimated daily rail movements along the Main Southern Line and the SSFL in the vicinity of the Proposal under the no-build scenario are shown in Table 5.

It should be noted that, in accordance with RING, noise from network rail lines are assessed during a 15-hour daytime period, from 7.00am until 10.00pm, and a 9-hour night time period, from 10.00pm until 7.00am. Accordingly, the project rail movements along the Main Southern Line and the SSFL are defined for these periods.

Table 5 Daily Rail Movements – no-build scenario

Year	Time Period	Train Type	Movements
2020	Day (7.00am – 10.00pm)	Freight	28
		Commuter	124
	Night (10.00pm – 7.00am)	Freight	21
		Commuter	44

Predicted rail noise levels without the Proposal

The predicted L_{Aeq} rail noise levels at nearby noise sensitive receivers at Casula under the no-build scenario, based on the additional noise measurements undertaken and the projected rail movements from the SSFL Operational Noise and Vibration Management Plan are presented in Table 6. These predicted noise levels are presented for the 15-hour day and 9-hour night RING assessment periods for network rail lines.

Table 6 Predicted Rail Noise Levels – no build scenario

Monitoring Location	$L_{Aeq, period}$ Noise Level	
	Day (7.00am – 10.00pm)	Night (10.00pm – 7.00am)
RM1	49.3	48.9
RM2	43.1	43.6
RM3	52.4	53.1

Assessment of the impacts on rail noise from the Proposal on nearby sensitive receivers

The predicted L_{Aeq} rail noise levels at the monitoring locations, under the no-build scenario, with the Proposal only, and the total combined L_{Aeq} rail noise levels are shown in Table 7, along with the increase in noise levels at the noise monitoring location as a result of the operation of the Proposal. The combined noise levels presented in Table 7 are equal to the logarithmic sum of the predicted existing rail noise levels, and the predicted rail noise levels from the Proposal alone.

To facilitate an assessment of rail noise levels against the RING criteria for private non-network rail lines, which are defined for the day, evening and night time assessment periods, the existing L_{Aeq} rail noise levels during the evening (6.00pm – 10.00pm) are assumed to be equal to those during the daytime (7.00am – 6.00pm). This is considered a reasonable assumption since much of the evening peak commuter rail movements occur within the evening period.

The results in Table 7 demonstrate compliance with the established RING criteria for private non-network rail lines at the monitoring locations, with the exception of RM1, where the predicted evening and night time L_{Aeq} rail noise levels from the project exceed the RING criterion for a private non-network rail line by 1.2 dBA and 3.9 dBA, respectively. However, at this location, the Proposal would result in an increase in the total evening and night time L_{Aeq} rail noise levels of less than 2 dBA, which is considered unlikely to be noticeable, and does not warrant mitigation.

The predicted increase in total rail noise levels during the evening, with the Proposal, at RM2 is more than 2 dBA. However, since the predicted $L_{Aeq,evening}$ rail noise level at RM2, due to the Proposal alone, complies with the RING criterion for a private non-network rail line, no mitigation is considered necessary.

Table 7 Predicted Future Rail Noise Levels – with Proposal

Monitoring Location	$L_{Aeq, period}$ Noise Level (dBA)																	
	No-build scenario			Operation of the Proposal along the Rail Link only			RING Criteria			Exceedance[2] of RING criteria from operation along the Rail Link y			Build scenario[3]			Increase in rail noise at monitoring locations with the Proposal (Build minus No-build)		
	D[1]	E[1]	N[1]	D[1]	E[1]	N[1]	D[1]	E[1]	N[1]	D[1]	E[1]	N[1]	D[1]	E[1]	N[1]	D[1]	E[1]	N[1]
RM1	49.3	49.3	48.9	44.8	46.2	43.9	55	45	40	0	**1.2**	**3.9**	50.6	51.0	50.1	1.3	1.7	1.2
RM2	43.1	43.1	43.6	40.6	42.0	39.6	55	45	40	0	0	0	45.0	45.6	45.1	1.9	2.5	1.5
RM3	52.4	52.4	53.1	38.6	40.0	37.7	55	45	40	0	0	0	52.6	52.6	53.2	0.2	0.2	0.1

1. D = 7.00am-6.00pm; E = 6.00pm – 10.00pm; N = 10.00pm-7.00am.
2. Exceedance of applicable RING criteria for a private non-network rail line.
3. "Build" Scenario is the logarithmic sum of the rail noise levels for the no-build scenario with the operation of the Proposal

SLEEP DISTURBANCE

Following the EIS Exhibition for the Proposal, EPA have made a submission, requesting further detail on potential sleep disturbance impacts from the Proposal, particularly due to rail movements associated with the Proposal. This submission from EPA is presented in Table 8.

Table 8 EPA Submission Relating to Sleep Disturbance from Rail Movements

Agency	Submission
EPA	Further detail should be provided on sleep disturbance impacts from the project, as it is likely to increase the number of events above Lmax 65 dBA (55 dBA indoors). Predicted LAmax rail noise levels were between 7 and 14 dBA above the screening criteria at the three receiver catchment areas modelled (Casula, Glenfield and Wattle Grove). Casula was the only suburb where the 95th percentile LAmax was predicted to be above 65 dBA (up to 67 dBA), indicating that one out of six expected rail movements in the night time could contribute an LAmax event above 65 dBA (roughly equal to 55 dBA inside a habitable room). The assessment relied on research summarised in the NSW Road Noise Policy to conclude that freight rail movements associated with the project, in the absence of wheel squeal, were unlikely to awaken people from sleep or affect health and wellbeing significantly. It also noted: • existing movements on the Southern Sydney Freight Line and Main South Line were likely to contribute LAmax events above 65 dBA • LAmax noise levels from the project were "unlikely to cause a noticeable change to the existing acoustic environment". But the project is likely to increase the number of LAmax events above 65 dB outdoors (55 dB indoors) at the nearest sensitive receiver in Casula, increasing the chance of sleep disturbance. As suggested by the application notes for the industrial noise policy, further detail should be provided on maximum noise level events during the night time. For example, by comparing the number of events per night above LAmax 65 dB outdoors with the project and without the project.

As presented in Section 8.2.3 of the NVIA, rail movements associated with the Proposal are predicted to result in L_{Amax} noise levels above 65 dBA at the most affected point in Casula. As presented above, in response to submissions regarding existing levels of rail noise near the Proposal, noise monitoring has recently been conducted at a number of locations in Casula. This monitoring was conducted specifically with a view to establishing the existing $L_{Aeq,period}$ rail noise levels near the Proposal, however is also useful in establishing existing maximum noise levels in the area. Monitoring location RM1, as shown in Figure 1, is representative of the area of Casula where L_{Amax} noise levels from rail movements are predicted to exceed 65 dBA, typically during one rail event per night.

The noise monitoring data from RM1 was analysed to identify maximum noise events. Since the monitoring was not conducted over an entire night time period, the number of identified events during the period 11.00pm – 3.00am was scaled to represent a typical 9-hour night time period (10.00pm – 7.00am). Table 11 presents the estimated number of noise events above 65 dBA L_{Amax} during a typical night for both the existing environment, and the future case where the Proposal would contribute one additional event above 65 dBA.

Table 9 Existing and Future Night Time Noise Events Above 65 dBA L_{Amax} – RM1

Existing (no Proposal)		Future (with Proposal)	
Measured Events (11pm – 3am)	Estimated Nightly Events (10pm – 7am)	Proposal Contribution	Total
15	34	1	35

Table 11 demonstrates that the contribution of the Proposal to the total number of noise events above 65 dBA is small, and is considered unlikely to result in a noticeable change to the existing maximum noise level environment and as a result is unlikely to result in additional sleep disturbance issues.

VIBRATION IMPACTS AT HERITAGE BUILDINGS

During the EIS exhibition for the Proposal, the Moorebank Heritage Group (MHG) and Liverpool City Council (LCC) have made submissions identifying that the NVIA had not specifically mentioned Kitchener House. The LCC submission is presented in Table 10.

Table 10 Submissions Related to Heritage Buildings

Agency	Submission
LCC	The EIS has failed to assess the potential noise and vibration impacts on adjacent sites Kitchener House and Glenfield Farm. Due to the heritage significance of these sites additional assessment should be undertaken to ensure the potential impacts to this site are completely considered.

Glenfield Farm is located at 88 Leacocks Lane, Casula on land zoned as R5 Large Lot residential and has been treated as a residential receiver for noise assessment purposes. Glenfield Farm is located more than 480 metres west of the construction footprint of the Proposal.

With regards to vibration impacts, given the distance of Glenfield Farm from the operational footprint of the Proposal (more than 480m), vibration impacts at Glenfield Farm are not anticipated, and no further assessment of vibration impacts at Glenfield Farm is considered warranted or necessary.

As such, this section of the Noise Technical Memorandum presents the following:

- A summary of the vibration assessment presented in the NVIA from the EIS;
- Identification of Kitchener House as a vibration sensitive receiver;
- Establishment of relevant vibration criteria;
- Assessment of potential vibration impacts at Kitchener House; and,
- Vibration management and mitigation measures.

Summary of NVIA Vibration Assessment

Table 6-10 in Section 6.6 of the NVIA presented the safe working distances, as presented in the Construction Noise Strategy (TCA, 2012), for vibration intensive plant most likely to be used during the construction of the Proposal. The safe working distances in TCA (2012) have been developed specifically to satisfy the requirements of the EPA's vibration guideline – Assessing Vibration: a technical guide (DECCW, 2006). At the time of preparing the NVIA for the EIS, no sensitive buildings of land uses had been identified within the safe working distances of the identified construction plant for either cosmetic damage or human response impacts.

Identification of Vibration Sensitive Receivers near the Proposal

Kitchener House is located on a parcel of land that is zoned for industrial use, it is treated as an industrial receiver for noise assessment purposes. Kitchener house is located further away from the MPW Stage 2 site than DJLU (I2) and ABB (I3) and since predicted operational and construction noise levels comply with the established noise criteria at DJLU and ABB, they would also comply at Kitchener House.

With respect to potential vibration impacts, since Kitchener House is of particular heritage significance, consideration should be given to construction vibration impacts, with a view to protecting Kitchener House from structural damage.

Vibration Criteria for Kitchener House

There are currently no Australian Standards or guidelines to provide guidance on assessing the potential for building damage from vibration. It is common practice to derive goal levels from international standards. British Standard BS 7385:1993 and German Standard DIN 4150:1999 both provide goal levels, below which vibration is considered insufficient to cause building damage. Of the two standards, DIN 4150 is the more stringent. Table 11 summarises the goal levels specified in DIN 4150.

With regard to these levels DIN 4150 states:

> *"Experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur. If damage nevertheless occurs, it is to be assumed that other causes are responsible. Exceeding* [these] *values does not necessarily lead to damage; should they be significantly exceeded, however, further investigations are necessary."*

Table 11 Guideline Values for Vibration Velocity to be used when Evaluating the Effects of Short-Term Vibration on Structures
[Source: Table 1, DIN 4150-3:1999]

Type of Structure	Guideline Values for Velocity – PPV (mm/s)		
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20
Structures that, because of their particular sensitivity to vibration, cannot be classified under either of the other classifications and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10

Due to the historical significance of Kitchener House, and without knowing the particular sensitivity of these buildings to vibration impacts, it is recommended that vibration levels during construction of the MPW Stage 2 Proposal do not exceed those in the bottom row of Table 11. Additionally, during the preparation of the *Construction Noise and Vibration Management Plan* (CNVMP), to be prepared as part of the *Construction Environmental Management Plan* (CEMP) for the Proposal, it is recommended that given the proximity of Kitchener House to the construction footprint of the Proposal, the building should be inspected by a suitably qualified structural engineer to complete a dilapidation survey, and to identify any features of the building construction that make it particularly sensitive to vibration impacts. If no such features are identified, it is recommended that the vibration limits for Kitchener House are revised to those for dwellings in Table 11.

Potential Vibration Impacts at Kitchener House

The recommended safe working distances for vibration intensive plant suggested in the Transport Construction Authority's *Construction Noise Strategy* (2012) have been adopted in this assessment to evaluate the potential for vibration impacts on Kitchener House. Table 12 sets out the recommended safe working distances for various vibration intensive plant.

Table 12 Recommended Safe Working Distances for Vibration Intensive Plant

Item	Description	Safe Working Distance	
		Cosmetic Damage	Human Response
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 7-13 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	(300 kg – 5 to 12 t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18 t excavator)	7 m	23 m
Large Hydraulic Hammer	1600 kg – 18 to 34 t excavator	22 m	73 m
Pile Boring	≤ 800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Source: Construction Noise Strategy, 2012, Transportation Construction Authority

Of the construction works periods, only the works on Moorebank Avenue as part of Works Period D would have the potential to result in vibration intensive plant being operated close to Kitchener House. The construction footprint for these works is approximately 20 metres from the nearest façade of Kitchener House and vibratory rollers have been identified as required plant items for works on Moorebank Avenue. Therefore, there is potential for vibration intensive plant to come within the recommended safe working distances for cosmetic damage should vibratory rollers greater than seven tonnes and more than 300 kN be used.

Vibration Management / Mitigation Measures

The preceding sections have identified the potential for vibration intensive construction plant, associated with the Proposal, to be operated near Kitchener House, within the TCA (2012) recommended safe working distances for cosmetic damage.

It should be noted that the potential for impact depends heavily on the exact type and size of construction plant used, and the locations in which it is used. Accordingly, this vibration assessment should be revised as part of the CEMP when greater detail is available regarding the exact type of plant to be used, and the exact locations where it will be used.

Notwithstanding the above, if any of the plant items in Table 12 are proposed to be operated within their respective “Cosmetic Damage” safe working distances, from Kitchener House, then attended vibration monitoring should be conducted at Kitchener House to ensure that the vibration levels in Table 11 are not exceeded. If exceedances are identified, the work should cease immediately, and alternative construction methods should be used.

Additionally, during the preparation of the CNVMP, to be included as part of the CEMP for the Proposal, it is recommended that given the proximity of Kitchener House to the construction footprint of the Proposal, the building should be inspected by a suitably qualified structural engineer to complete a dilapidation survey, and to identify any features of the building construction that make it particularly sensitive to vibration impacts. If no such features are identified, it is recommended that the vibration limits for Kitchener House are revised to those for dwellings in Table 11.

I trust this information is sufficient. Please contact us if you have any further queries.

Yours faithfully
WILKINSON MURRAY

Nic Hall
Manager (Wollongong)

APPENDIX A

NOISE MEASUREMENT RESULTS

Table A-1 Rail Noise Measurement Results

Measurement Location	Date	Time	Duration	Measured Noise Levels (dBA)			Type
				L_{Aeq}	SEL	L_{Amax}	
RM1	9/02/2017	22:15	96	60.2	80.0	67.7	Freight
RM1	9/02/2017	22:29	30	58.8	73.6	62.7	Commuter
RM1	9/02/2017	22:33	33	57.0	72.2	61.4	Commuter
RM1	9/02/2017	22:35	30	58.3	73.1	62.7	Commuter
RM1	9/02/2017	22:38	92	59.3	78.9	65.1	Freight
RM1	9/02/2017	22:40	17	58.0	70.3	62.8	Commuter
RM1	9/02/2017	22:41	31	56.9	71.8	60.7	Commuter
RM1	9/02/2017	22:02	39	55.4	71.3	59.9	Commuter
RM1	9/02/2017	23:06	37	56.8	72.5	61.6	Commuter
RM1	9/02/2017	23:11	36	56.3	71.8	60.9	Commuter
RM1	9/02/2017	23:19	85	58.0	77.3	64.1	Freight
RM1	9/02/2017	23:28	79	61.6	80.6	67.5	Freight
RM1	9/02/2017	23:36	38	55.6	71.3	60.0	Commuter
RM1	9/02/2017	23:41	40	57.5	73.5	63.2	Freight
RM1	10/02/2017	0:03	36	54.0	69.5	57.3	Commuter
RM1	10/02/2017	0:07	72	57.1	75.6	61.9	Freight
RM1	10/02/2017	0:13	63	50.3	68.3	57.4	Freight
RM1	10/02/2017	0:20	81	57.4	76.5	62.2	Commuter
RM1	10/02/2017	0:24	62	56.4	74.3	63.3	Commuter
RM1	10/02/2017	0:35	38	57.4	73.2	63.3	Commuter
RM1	10/02/2017	0:41	35	55.0	70.5	59.8	Commuter
RM1	10/02/2017	1:01	35	56.3	71.7	61.5	Commuter
RM1	10/02/2017	1:11	58	55.6	73.2	61.3	Commuter

Measurement Location	Date	Time	Duration	Measured Noise Levels (dBA)			Type
				L_{Aeq}	SEL	L_{Amax}	
RM1	10/02/2017	1:15	131	62.8	83.9	70.3	Freight
RM1	10/02/2017	1:18	113	59.1	79.4	63.2	Freight
RM1	10/02/2017	1:22	52	55.5	72.6	60.6	Freight
RM1	10/02/2017	1:34	73	61.5	80.1	68.3	Freight
RM1	10/02/2017	1:35	36	55.4	70.9	59.5	Commuter
RM1	10/02/2017	1:44	37	59.4	75.0	65.4	Commuter
RM1	10/02/2017	2:17	91	58.5	78.1	61.7	Freight
RM1	10/02/2017	2:55	72	61.6	80.1	67.0	Freight
RM2	10/02/2017	22:07	28	56.2	70.7	61.1	Commuter
RM2	10/02/2017	22:12	26	39.7	53.8	43.1	Commuter
RM2	10/02/2017	22:20	94	50.0	69.7	62.4	Freight
RM2	10/02/2017	22:32	24	43.9	57.6	51.0	Commuter
RM2	10/02/2017	22:36	28	41.1	55.5	45.4	Commuter
RM2	10/02/2017	22:40	27	55.8	70.0	65.4	Commuter
RM2	10/02/2017	23:02	25	45.0	59.1	49.5	Commuter
RM2	10/02/2017	23:06	97	60.8	80.6	69.1	Freight
RM2	10/02/2017	23:10	28	50.5	65.0	59.8	Commuter
RM2	10/02/2017	23:18	27	50.6	65.0	56.3	Commuter
RM2	10/02/2017	23:33	25	43.5	57.4	49.4	Commuter
RM2	10/02/2017	23:37	26	47.1	61.3	55.4	Commuter
RM2	10/02/2017	23:41	27	43.7	57.9	49.6	Commuter
RM2	10/02/2017	23:45	27	44.5	58.8	51.1	Commuter
RM2	11/02/2017	0:09	28	47.1	61.6	53.9	Commuter
RM2	11/02/2017	0:17	28	46.3	60.7	53.1	Commuter
RM2	11/02/2017	0:32	27	44.7	59.0	51.4	Commuter

Measurement Location	Date	Time	Duration	Measured Noise Levels (dBA)			Type
				L_{Aeq}	SEL	L_{Amax}	
RM2	11/02/2017	0:35	26	43.8	58.0	50.3	Commuter
RM2	11/02/2017	0:44	21	41.8	55.0	45.6	Commuter
RM2	11/02/2017	0:48	26	48.8	62.9	53.9	Commuter
RM2	11/02/2017	0:58	29	44.3	58.9	49.9	Commuter
RM2	11/02/2017	1:00	59	51.0	68.8	55.5	Freight
RM2	11/02/2017	1:03	24	41.0	54.8	47.4	Commuter
RM2	11/02/2017	1:12	26	45.2	59.4	51.9	Commuter
RM2	11/02/2017	1:15	26	45.4	59.6	52.7	Commuter
RM2	11/02/2017	1:18	28	50.7	65.2	61.3	Commuter
RM2	11/02/2017	1:23	31	47.3	62.1	53.3	Commuter
RM2	11/02/2017	1:33	25	43.1	57.1	48.6	Commuter
RM2	11/02/2017	1:34	29	45.7	60.3	52.7	Commuter
RM2	11/02/2017	1:36	23	41.9	55.5	46.9	Commuter
RM2	11/02/2017	1:39	24	40.7	54.6	46.2	Commuter
RM2	11/02/2017	1:42	27	45.2	59.4	50.2	Commuter
RM2	11/02/2017	1:48	58	56.4	74.0	69.7	Freight
RM2	11/02/2017	1:59	27	44.3	58.6	50.7	Commuter
RM2	11/02/2017	2:02	26	44.9	59.1	52.6	Commuter
RM2	11/02/2017	2:15	25	42.2	56.3	48.9	Commuter
RM2	11/02/2017	2:19	42	47.1	63.3	52.9	Freight
RM2	11/02/2017	2:26	26	44.3	58.5	52.0	Commuter
RM2	11/02/2017	2:57	27	42.9	57.2	48.8	Commuter
RM3	2/02/2017	22:06	27	57.3	71.7	62.6	Commuter
RM3	2/02/2017	22:09	27	58.3	72.6	64.8	Commuter
RM3	2/02/2017	22:15	141	65.5	86.9	73.7	Freight

Measurement Location	Date	Time	Duration	Measured Noise Levels (dBA)			Type
				L_{Aeq}	SEL	L_{Amax}	
RM3	2/02/2017	22:29	27	57.3	71.6	62.7	Commuter
RM3	2/02/2017	22:32	24	53.7	67.5	57.5	Commuter
RM3	2/02/2017	22:39	27	54.6	69.0	59.6	Commuter
RM3	2/02/2017	22:43	24	53.9	67.8	57.4	Commuter
RM3	2/02/2017	23:04	27	56.5	70.8	61.9	Commuter
RM3	2/02/2017	23:09	27	55.1	69.4	60.7	Commuter
RM3	2/02/2017	23:13	28	56.2	70.7	61.7	Commuter
RM3	2/02/2017	23:35	29	56.8	71.5	61.3	Commuter
RM3	2/02/2017	23:42	64	61.2	79.2	65.5	Freight
RM3	2/02/2017	23:50	23	53.7	67.3	57.5	Commuter
RM3	3/02/2017	0:08	27	59.0	73.3	65.2	Commuter
RM3	3/02/2017	0:11	27	54.9	69.2	60.3	Commuter
RM3	3/02/2017	0:18	27	54.8	69.1	59.5	Commuter
RM3	3/02/2017	0:31	24	54.0	67.8	58.2	Commuter
RM3	3/02/2017	0:36	27	57.9	72.2	63.6	Commuter
RM3	3/02/2017	0:50	61	66.0	83.8	71.5	Freight
RM3	3/02/2017	1:02	26	54.9	69.1	59.5	Commuter
RM3	3/02/2017	1:05	28	54.7	69.2	59.1	Commuter
RM3	3/02/2017	1:07	26	55.6	69.8	60.7	Commuter
RM3	3/02/2017	1:15	28	56.4	70.9	61.7	Commuter
RM3	3/02/2017	1:18	40	63.4	79.5	70.6	Freight
RM3	3/02/2017	1:22	27	56.1	70.4	61.0	Commuter
RM3	3/02/2017	1:36	25	53.5	67.5	57.3	Commuter
RM3	3/02/2017	1:44	27	58.3	72.6	63.9	Commuter
RM3	3/02/2017	1:46	125	67.7	88.7	78.8	Freight

Measurement Location	Date	Time	Duration	Measured Noise Levels (dBA)			Type
				L_{Aeq}	SEL	L_{Amax}	
RM3	3/02/2017	2:16	87	65.3	84.7	72.1	Freight
RM3	3/02/2017	3:01	69	65.7	84.1	74.3	Freight
RM3	3/02/2017	3:18	70	62.6	81.0	70.0	Freight