



Review of EIS and Vibration Impact Assessment for WestConnex M4 East

Independent Review

Prepared for Department of Planning and Environment | 19 January 2016



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Final

Report J15092RP1 | Prepared for Department of Planning and Environment | 19 January 2016

Approved by **Najah Ishac**

Position Director

Signature



Date 19 January 2016

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Document Control

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Table of contents

Chapter 1	Introduction	1
Chapter 2	The proposed project	3
Chapter 3	Methodology review	5
3.1	Existing noise environment and assessment locations	5
3.2	Noise catchment areas (NCAs)	5
3.3	Ambient and background noise monitoring	6
3.3.1	Data review	7
Chapter 4	Assessment of operational noise	9
4.1	Road traffic noise during operations	9
4.1.1	Adopted criteria	9
4.1.2	Noise modelling	9
4.1.3	Results	10
4.1.4	Noise management and mitigation	11
4.2	Fixed noise sources	15
4.2.1	Adopted criteria	16
4.2.2	Noise modelling	18
4.2.3	Results	19
4.2.4	Noise management and mitigation	21
Chapter 5	Noise and vibration during construction	23
5.1	Adopted criteria	23
5.2	Noise modelling	24
5.2.1	Adopted software	24
5.2.2	Sound emission levels	24
5.3	Results	24
5.3.1	Airborne noise	24
5.3.2	Construction road traffic noise	27
5.3.3	Ground borne noise	27
5.3.4	Vibration	28
5.3.5	Blasting	28
5.4	Noise management and mitigation	28
Chapter 6	Gap analysis	33
Chapter 7	Post exhibition review	41
7.1	Government agencies	41
7.1.1	Environment Protection Authority (EPA)	41

Table of contents *(Cont'd)*

7.1.2	NSW Health	41
7.2	Local Councils	42
7.3	Community and other key stakeholders	42
Chapter 8	Preferred project review	45
8.1	Changes	45
8.2	Homebush Bay Drive interchange	45
8.3	Wattle Street interchange	46
8.4	Construction noise - Homebush Bay civil site expansion	46
8.5	Other modifications	46
Chapter 9	Draft recommended conditions	49
9.1	Land use survey	49
9.2	Construction hours	49
9.3	Construction noise and vibration	50
9.4	Construction traffic noise	52
9.5	Blasting	53
9.6	Operational noise and vibration	55

Appendices

A	Glossary of acoustic terms
B	EIS Noise and vibration report graphics
C	Response to gap analysis

Tables

4.1	Noise barriers in the study area	13
4.2	Summary of operation noise goals for ventilation facilities	17
5.1	Summary of highly noise affected residential receivers	26
5.2	Revised environmental management measures from the M4 East Submissions Report relevant to the management of noise and vibration	29
9.1	Airblast overpressure criteria	54
9.2	Ground vibration criteria for human comfort (AS 2187.2)	54
A.1	Glossary of acoustic terms	A.1
A.2	Perceived change in noise	A.2
C.1	Preliminary Review Comments – Noise and Vibration	C.1

Figures

A.1	Common noise levels	A.3
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1 Introduction

EMM Consulting Pty Limited (EMM) has been engaged by the Department of Planning and Environment (DP&E) to complete an independent review of the noise and vibration impact assessment (NVIA) for the WestConnex M4 East project.

EMM's involvement has been generally limited to a desktop review of information, a number of meetings with DP&E and the proponent, as well as a drive-by site visit to some parts of the project area. EMM has not completed independent modelling of impacts to verify outcomes.

EMM's scope of work has included the following:

- Impact assessment review
 - EIS methodology review including its technical adequacy and completeness of the NVIA, taking into account relevant noise and vibration impact assessment guidelines, requirements and legislation (including the Secretary's Environmental Assessment Requirements (SEARs)) and impact assessment best practice;
 - analysis of the results of the noise and vibration impact assessment, with reference to applicable legislation, guidelines and comparable projects;
 - EIS assessment and mitigation review, including the appropriateness and effectiveness of management and mitigation measures recommended for the project;
 - gap analysis; and
 - post-exhibition document review.
- Provision of draft recommended conditions that could be applied to avoid, minimise, mitigate and/or manage the noise and vibration impacts (should approval of the project be recommended).

The following documents were reviewed as part of EMM's work:

- SLR Consulting, September 2015, WestConnex M4 East Noise and Vibration impact assessment (EIS Volume 2C, Appendix I);
- AECOM Australia Pty Ltd and GHD Pty Ltd, September 2015, WestConnex M4 East Environmental Impact Statement (EIS) Volume 1A;
- EIS Website Submissions, available at <http://majorprojects.planning.nsw.gov.au>;
- SLR Consulting, October 2015, WestConnex M4 East Additional Noise Logger Survey Monitoring Summary;
- December 2015, WestConnex M4 East Submissions Report; and
- Leighton Samsung John Holland, December 2015, Draft Construction noise and vibration management plan.

Appendix A provides a glossary of acoustic terms used in this report.

2 The proposed project

The project is a component of the larger WestConnex project and involves the construction and operation of twin tunnels and associated surface works to connect WestConnex to the existing road network. The key elements are:

- two new three-lane tunnels approximately 5.5 km in length;
- widening, realignment and resurfacing of the M4 between Homebush Bay Drive and Underwood Road at Homebush;
- upgrade of the existing Homebush Bay Drive interchange;
- a new westbound on-ramp from Parramatta Road to the M4 at Powells Creek;
- an interchange at Concord Road, North Strathfield/Concord with on-ramps to the eastbound tunnel and off-ramps from the westbound tunnel;
- modification of the intersection of the existing M4 and Parramatta Road;
- an interchange at Wattle Street (City West Link), Haberfield with an on-ramp to the westbound tunnel and an off-ramp from the eastbound tunnel; on and off-ramps at this interchange that would provide access to the M4–M5 Link, and the westbound lanes of Wattle Street would be realigned;
- an interchange at Parramatta Road at Ashfield/Haberfield, with an on-ramp to the westbound tunnel and an off-ramp from the eastbound tunnel, and the westbound lanes of Parramatta Road would be realigned;
- installation of tunnel ventilation systems, including ventilation facilities within the existing M4 road reserve near Underwood Road at Homebush (western ventilation facility) and at the corner of Parramatta Road and Wattle Street at Haberfield (eastern ventilation facility); provision has also been made for a fresh air supply facility at Cintra Park at Concord;
- associated surface road work on the arterial and local road network, including reconfiguration of lanes, changes to traffic signalling and phasing and permanent road closures at a small number of local roads;
- pedestrian and cycle facilities, including permanently re-routing a portion of the existing eastbound cycleway on the northern side of the M4 from west of Homebush Bay Drive to near Pomeroy Street, and a new westbound cycleway on-ramp connection from Queen Street at North Strathfield to the existing M4;
- tunnel support systems and services such as electricity substations, fire pump rooms and tanks, water treatment facilities and fire and life safety systems including emergency evacuation infrastructure;
- motorway operations complex on the northern side of the existing M4, east of the Homebush Bay Drive interchange;

- provision of:
 - road infrastructure and services to support the future implementation of smart motorway operations (subject to separate planning approval);
 - new and modified noise walls; and
 - low noise pavement for new and modified sections of the existing M4.
- installation of tolling gantries and traffic control systems along the length of the project; and
- temporary construction ancillary facilities and temporary works to facilitate the construction of the project.

Refer to Appendix B (extracted EIS noise and vibration report graphics) for an indicative site layout, tunnel portals, noise monitoring locations, construction footprint and facilities, sensitive receivers and noise catchment areas (NCAs), noise barriers, ventilation facilities and surface works.

3 Methodology review

3.1 Existing noise environment and assessment locations

The EIS NVIA adopts 23 noise catchment areas (NCAs) and relies upon 23 monitoring locations (one in each NCA) as representative of baseline conditions at all potentially exposed properties within the predefined NCAs.

The monitoring locations and NCAs are shown in Figure 5 of the EIS NVIA report which has been reproduced in Appendix B herein.

3.2 Noise catchment areas (NCAs)

The adopted noise catchment areas (NCAs) are large and a single noise monitoring location is used within each NCA to represent the whole acoustic climate therein. The monitoring locations are used to serve two purposes. That is, to establish background noise for setting appropriate criteria for construction and fixed plant noise assessment, and to establish the existing level of traffic noise for assessment of future traffic noise impacts. Noise monitoring for these two purposes often has conflicting monitor positioning requirements. This could lead to shortcomings in the impact assessment of construction and fixed plant noise, as often the monitoring location is the closest to the main roadway nearby (eg existing M4 alignment) and not further away where background noise levels will be lower. While traffic noise reduces by 3 dB per doubling of distance and construction or fixed plant by 6 dB per doubling of distance, accounting for shielding due to barriers or buildings could lead to greater reductions of traffic noise at say beyond two rows of houses from the road. This level of attenuation is not necessarily the same for construction sites and fixed plant sources (which could be considerably elevated as per the ventilation building for example).

The EIS NVIA report Table 8 confirms via attended noise monitoring and observations that most monitoring locations were in environments dominated by traffic noise from roads. Appendix C maps and photographs also confirm that monitors were positioned on property boundaries closest or most exposed to the M4 motorway or other road nearby, which ensures the monitors represent the noisiest position for the individual property and the whole NCA. For some locations (eg L5) the microphone is not in a free field environment as required for background (or rating background level (RBL) as per the EPA's Industrial Noise Policy (INP)) determination for the purposes of construction and fixed plant noise impact assessment. The positioning of most of the monitors are suitable for traffic noise impact assessment and therefore possibly unsuitable for construction noise impact assessment. There are some exceptions to this whereby the monitors are positioned in locations specifically to address construction noise from proposed nearby compounds or work sites.

The data in Appendix C demonstrates that RBL values are significantly lower when measurements are undertaken at locations further away from major roads. While relationships between distance from roadways and RBL values may not be possible, it is clear that consistently quieter areas exist away from main roads. For example, the data from four nearby monitoring stations presented in Appendix C show the two that are not exposed to the M4 or Parramatta Road are afforded a lower and the same daytime RBL of 41 dB (L7 and L9), while at the other two (L6 and L8) the RBLs are 48 dB and 55 dB respectively. That is, a considerable 14 dB difference in daytime RBL is measured between L8 to L7 or L9. This difference is not as significant, but still material at up to 7 dB (L8 to L9), at night when traffic volumes are lower. It is therefore plausible that other NCAs where single monitoring locations are used to represent the entire NCA for the purposes of construction or fixed plant noise impact assessment could lead to underestimation of impacts.

The requirements for noise monitoring for the two purposes are stipulated in the EPA's Interim Construction Noise Guideline (ICNG) (and INP) and the EPA's Road Noise Policy (RNP) for construction (and operation) and road traffic noise, respectively. The approach should also not result in overly conservative outcomes where RBL monitoring positions are less exposed to the chosen assessment location. An appropriate and representative balance needs to be achieved.

This issue has been subsequently addressed in the proponent's response to the Gap Analysis shown in Appendix C (refer Item 1 in Table C.1).

EMM was consulted, and provided input to, and has reviewed additional data and analysis of further noise monitoring as provided by the proponent (correspondence dated 10/12/12 and data supplied 23/12/15). Data at an additional 14 monitoring locations was obtained between 16 to 26 October 2015. Additional monitoring was completed at 10 Welfare Street, 38 Loftus Crescent and 50 Underwood Road Homebush, 18 Elliott Street and 5 Carrington Street North Strathfield, 5 Thornleigh Avenue, 15 Edward Street and 6 Loftus Street Concord, 12 Luke Avenue Burwood, 174 Queens Road Canada Bay, 28 Page Avenue Ashfield, 5 Wolseley Street, 26 Walker Avenue and 1 Walker Avenue Haberfield.

The additional monitoring data confirms that background noise levels at locations set relatively further from main roads are generally lower than those adopted in the EIS for the same catchment. For example, additional monitoring location 1 (ADD01) for NCA1 is 10 Welfare Street, Homebush, and shows RBLs of 51 dB(A), 49 dB(A) and 46 dB(A) for the day, evening and night, respectively. This compares to the EIS location L23 (12 Flemington Road) having marginally higher RBLs of 53 dB(A), 53 dB(A) and 49 dB(A) for the day, evening and night, respectively. Another example is additional monitoring location 12 (ADD12) for NCA14, 5 Wolseley Street, Haberfield. This location shows RBLs of 45 dB(A), 45 dB(A) and 42 dB(A) as compared to the adopted L11 (for this NCA) of the EIS of 58 dB(A), 59 dB(A) and 52 dB(A) for the day, evening and night, respectively. The RBL and therefore construction and fixed plant operation noise criteria for these areas of NCA14 will be significantly lower than at other areas (eg by 13 dB during the day and 10 dB during the night). It is expected that the Construction Noise and Vibration Management Plan (CNVMP) will adopt the lower (more conservative) RBLs as appropriate for each area in establishing criteria for construction works.

Additional monitoring typically completed part of further studies (eg during detailed design or used in CNVMP or ONVMP) will qualify and quantify the assessment of impacts and improve identification of appropriate mitigation. This approach is considered adequate and addresses the issue of establishing appropriate construction noise criteria.

3.3 Ambient and background noise monitoring

Baseline noise monitoring was completed as part the NVIA primarily to obtain existing road traffic noise levels and rating background levels (RBLs) for setting noise criteria to assess proposed construction works and fixed plant operational noise levels.

For RBL determination, the INP recommends collection of seven days of 'valid' data at locations representative of the most exposed sensitive receivers to the proposal. This generally means data unaffected by rain or winds in excess of 5 m/s, with data exclusion rules applying as described in Appendix B of the INP.

For the assessment of road traffic noise the RNP states "...a minimum of seven consecutive days is preferred".

It is important to monitor weather conditions during any baseline noise surveys and the INP recommends, for example, monitoring wind speed at the microphone position for the purposes of applying the data

exclusion rules and calculation of final representative noise levels. It is common practice to adopt nearby weather stations operated by the Bureau of Meteorology (BoM) for such purposes, so long as these can be shown to be representative of the area where noise monitoring occurred.

3.3.1 Data review

Review of the noise monitoring data provided in Appendix C of the EIS NVIA report indicates data quantity is likely to be sufficient to satisfy the recommended seven day requirements of the INP and RNP at all locations. The monitoring was completed between the period 26 March to 9 April 2014. Consideration of weather conditions also appears to have been included, although EMM cannot conclusively verify this without conducting our own analysis of the raw data.

i Background noise monitoring

As noted above, the background noise monitoring was obtained over a sufficient monitoring period (in excess of seven days) although locations are considered only representative of areas exposed to relatively high levels of ambient noise (eg from nearby major roads). These however are likely to be the most exposed to proposed construction works and therefore an assessment for these category of receivers is considered appropriate. The daytime, evening and night time RBL values are provided in Table 7 of the EIS NVIA report as per the INP. Attended noise monitoring and observations are also provided in Table 8 of the EIS NVIA at all 23 long term monitoring sites as is good practice. In all cases, the attended monitoring observations confirm dominant presence of road traffic noise.

ii Road traffic noise monitoring

Most of the 23 long term monitoring locations are considered to be in positions exposed to road traffic noise. Concurrent road traffic counts were completed at nine locations during the noise monitoring period as shown in Appendix F1 of the EIS NVIA report and this data was used to validate the road traffic noise model. It appears that three traffic count locations did not have noise monitors in their vicinity and hence it is unclear as to their purpose. These are at the M4 Motorway west of Sydney Street ramp (eastbound), M4 Motorway east of Sydney Street ramp (westbound) and M4 Motorway westbound off-ramp to Homebush Bay Drive intersection.

iii Weather conditions

The analysis of noise monitoring data is said to have accounted for influences of weather conditions:

"The results of the noise monitoring have been processed to exclude noise identified as extraneous and/or data affected by adverse weather conditions (such as strong wind or rain) so as to establish representative noise levels in each area."

The EIS does not confirm that the EPA's INP procedures were followed nor which weather station data was used (ie Bureau of Meteorology or mobile weather stations at the noise monitors). Furthermore, the details regarding the implications of how much data actually remained 'valid' is not provided in accordance with the INP. However, the additional monitoring data and information supplied by the proponent (as noted in Section 3.2) confirms adoption of appropriate weather analysis. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.3.

4 Assessment of operational noise

4.1 Road traffic noise during operations

4.1.1 Adopted criteria

The Secretary's Environmental Assessment Requirements (SEARs) nominates the EPA's RNP for the assessment of operational road traffic noise. The EIS NVIA report references the Roads and Maritime's Noise Criteria Guideline (NCG) which is an interpretation of the RNP. This is considered appropriate and the RNP criteria have been adopted for the project.

The application of noise criteria relate to new road sections as well as redeveloped roads, with transition zones at Parramatta Road interchange, Wattle Street interchange and Concord Road interchange, as well as along the M4 Motorway between Homebush Bay Drive and Concord Road. This approach is considered appropriate and consistent with the RNP and NCG.

4.1.2 Noise modelling

i Software and algorithm

It is acknowledged that the adopted SoundPlan version 7.1 noise modelling software has been updated and is now at version 7.4. The NVIA states that since version 7.1, SoundPlan has not been verified for use on large infrastructure projects, and so newer version was not used for the purpose of this project. An explanation of differences between the two versions that could alter predicted levels has subsequently been provided in the proponent's submissions report.

The software applies the Calculation of Road Traffic Noise (CoRTN) algorithm, which is an appropriate tool once adjusted for Australian conditions. The modelling was completed for the existing year (2014) for validation purposes only, year of opening (2021) and 10 years after opening (2031). The 'Build' and 'No Build' options were modelled for the year of opening and 10 years after opening. This approach is consistent with the RNP.

ii Modelling parameters and calibration

A summary of noise modelling parameters is provided in Table 16 of the EIS NVIA report. The parameters adopted are considered to be appropriate, with the following qualifications:

- Australian conditions corrections - the stated Australian Road Research Board (ARRB) corrections of -1.7 dB and -0.7 dB for facade and free-field conditions respectively are assumed applied to both daytime and night time results. EMM understands that Roads and Maritime's preferred approach is that these corrections are only to apply to daytime predictions.
- $L_{eq}(\text{period})$ to $L_{eq}(1\text{hour})$ corrections - this is said to be done on the basis of monitoring data as summarised in Table 7 of the EIS NVIA report (ie the median of individual monitoring results). A median of L_{eq} values in Table 7 confirms a difference of +2.5 dB for the daytime as stated, however the night time difference is +4.0 dB and hence marginally lower than the adopted +4.4 dB. The consequence of this is a minor conservative approach to night time modelling.

The above corrections are considered to be nullified through the validation process detailed in Table 11 of the EIS NVIA report. However, the complexity of how corrections to predicted noise levels from congestion during the night period (10pm to 7am) are determined should be clarified, particularly when volumes would be appreciably lower than daytime. Table 11 indicates that the noise model underestimates free flowing traffic noise (Step 1) more often than not (17 of 24 predictions are underestimates). However, predictions for whole assessment periods (Step 2) overestimate more often than not (9 of 24 predictions are underestimates). The differences between Steps 1 and 2 are said to be related to traffic congestion factors. Of particular interest is the M4 night congestion factor where a minus 2.1 dB (overestimation) median correction is determined. This logic should be further explained as it is not clear why for example Step 2 is not the model's validation factor for the period. The latter would give rise to a median validation factor for the M4 of minus 1.3 dB (ie overestimation by the model) as opposed to the adopted 2.1 dB.

Expanding further on this and looking closely at logger location L23, through an analysis of measured $L_{eq,night}$ noise levels (Table 13) and traffic volumes provided in Appendix F, an estimate of the free-flowing traffic noise level is determined to be 48 dB(A). At this location, a night RBL of 49 dB(A) and L_{eq} of 57 dB(A) is presented at Appendix C. The charts show that L_{eq} noise levels do not drop below 51 dB(A) at night between midnight and 4am. These levels of ambient L_{eq} and background noise level could influence 'measured' traffic noise used to develop corrections in the model. Such issues should be investigated to determine whether they affect (conservatively or non-conservatively) the final correction factors used in the assessment.

The proponent has provided responses to the above in a follow-up to the Gap Analysis shown in Appendix C (refer Item 3 in Table C.1). It is expected that detailed design modelling will retest these issues as will the ultimate compliance testing post operations. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 conditions 27, 29 and 31 to 33.

4.1.3 Results

The assessment of road traffic noise extends to areas where noise levels are dominated by other non-project roads as defined in the NCG. That is, up to a maximum of 600m from the centre line of the outermost traffic lane on each side of the subject road. In highly urban areas this included other significant roads with noise levels that dominate at nearby receivers. Both project and non project roads were modelled in order to identify contributions from each and understand impacts more broadly and capture all receivers potentially eligible for treatment. This is considered to be an appropriate approach.

The noise modelling results are presented in tabular form for all assessed locations and as noise increase contours. Absolute noise level contours are not provided as per requirements of the Environmental Noise Management Manual (ENMM) (RTA, 2001).

Our review of the EIS NVIA operational noise traffic results are summarised as follows:

- all receiver relevant heights were included in noise modelling, however, at property treatment for multi-level residential buildings applied to ground and first floor levels only. This approach is not entirely consistent with the Road Noise Policy (RNP). The RNP states at Table 7 "The external points of reference for measurement are the two floors of the building that are most exposed to traffic noise". In most cases the ground and first floors could be the most exposed. It is understood that this level of scrutiny is not feasible at this stage of the project, but if possible the assessment should identify where potential exists for other floors to be worst affected if relevant. Alternatively confirm that all 'most affected' two floors are the ground and first floor, or otherwise note that this will be the approach adopted in detailed design and in likely consent conditions should approval be granted. The Roads and Maritime's approach is to only treat two floors of multi-storey residential buildings. It is our experience that this stems from limitations and cost benefit analysis of road side noise barriers as forms of mitigation. However, it is unclear why it is not feasible and reasonable to provide architectural treatment at all affected floors of multi level residential buildings where these are found to be eligible for treatment. Although the assessment does refer such exceedances for further consideration during the detailed design stage of the project.
- A total of 392 receiver floors were considered for additional noise mitigation. For larger scale multi-level residential apartments, each floor could include more than one residence.
- Additional noise mitigation in the form of low noise pavement and noise barriers has been appropriately considered.
- It is shown that the 2031 Build scenario results in 1078 and 1023 receivers over the NCG controlling criteria with mitigation for the daytime and night time, respectively.
- After mitigation, a total of 310 receiver floors are considered eligible for at property treatment. Of these, 284 are residential receivers (from 227 lots), with 37 of these lots identified to be greater than two floors. These 37 lots should be considered further during the detailed design stage of the project.
- Discussions on typical increases in maximum noise levels is provided as a range of increases from 2 dBA to '>10' dBA for six of the adopted NCAs. The upper end of the increases should be provided rather than an open ended >10 dBA reference. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 conditions 27 to 29 and 31 to 33.

4.1.4 Noise management and mitigation

The Roads and Maritime Noise Mitigation Guideline (NMG) was adopted for the project, which supersedes relevant practice notes in the RTA's ENMM. The NMG provides three triggers for consideration of noise mitigation and these are:

- Trigger 1
 - The predicted Build noise level exceeds the NCG controlling criterion and the noise level increase due to the project (ie the noise predictions for the Build minus the No Build) is greater than 2 dB.

- Trigger 2
 - The predicted Build noise level is 5 dB or more above the criteria (exceeds the cumulative limit) and the receiver is significantly influenced by project road noise, regardless of the incremental impact of the project.
- Trigger 3
 - The noise level contribution from the road project is acute (daytime $L_{Aeq(15\text{hour})}$ 65 dB or higher, or night-time $L_{Aeq(9\text{hour})}$ 60 dB or higher) then it qualifies for consideration of noise mitigation even if noise levels are dominated by another road.

For receivers that qualify for consideration of additional noise mitigation measures, potential noise mitigation measures are identified, in the order of preference from the list below:

1. Quieter pavement surfaces
2. Noise mounds
3. Noise barriers
4. At-property treatments

The above approach constitutes current good practice and is considered appropriate.

i Low noise pavement

The surface sections of M4 East carriageway and modified sections of the M4 carriageway were considered for low noise pavement. Limitations in applying low noise pavement across other parts of the project include lower vehicle speeds. Installation of the proposed low noise pavements is predicted to reduce noise levels by up to 2 dB with the result that 21 receivers (total floors) no longer require consideration of further additional noise mitigation (noise barriers). Low noise pavements will be subject to further consideration during detailed design.

ii Barriers

Figure 10 of the EIS NVIA shows the assessed road noise barriers (reproduced in Appendix B) with recommendations summarised in Table 19, reproduced below in Table 4.1. Recommended height is subject to further considerations during detailed design such as construction limitations, overshadowing, urban design and community preference.

Table 4.1 Noise barriers in the study area

Barrier reference	Existing Barrier Height (m)	Noise barrier details		
		Type	Length, m	Height, m
NW_CCRDPRTAL_01	-	New not reasonable	99	n/a
NW_CONCORD_01A	-	New not reasonable	151	n/a
NW_CONCORD_01B	-	New	187	3.0
NW_M4EB_01A	-	New	100	6.0
NW_M4EB_01B	6.0	Existing Retained / Existing Relocated	80	6.0
NW_M4EB_01C	4.2 to 6.0	Existing Relocated	116	4.2 to 6.0
NW_M4EB_01D	4.2	Existing Retained	60	4.2
NW_M4EB_01E	2.1	Existing Increase	93	4.0
NW_M4EB_01F	-	New	240	3.5
NW_M4EB_01G	3.4	Existing Relocated	144	3.4
NW_M4EB_01H	3.4	Existing Retained	210	3.4
NW_M4EB_02	2.5	Existing Retained / Existing Relocated	154	2.5
NW_M4EB_03	3.0	Existing Retained	124	3.0
NW_M4WB_01	-	New not reasonable	219	n/a
NW_M4WB_02A	3.5	Existing Relocated	34	3.5
NW_M4WB_02B	3.0 to 4.2	Existing Retained	234	3.0 to 4.2
NW_M4WB_02C	4.2	Existing Relocated	226	4.2
NW_M4WB_02D	-	New not reasonable	264	n/a
NW_PARRA_01B	-	New not reasonable	203	n/a
NW_PARRA_02A / B	-	New	162	2.0
NW_SYDNEY_01	-	New not reasonable	129	n/a
NW_WATTLE_01A	-	New	374	5.0
NW_WATTLE_01B	-	New	94	5.0
NW_WATTLE_01C	1	New not reasonable	51	n/a
NW_WATTLE_01D		New not reasonable	43	n/a
NW_WATTLE_01E		New not reasonable	19	n/a
NW_WATTLE_01F		New not reasonable	37	n/a
NW_WATTLE_01G	-	New	246	5.0

Barriers have been recommended for most of the M4 Motorway surface sections within the project area. Similarly, barriers have been recommended for the Concord Road interchange and Wattle Street. However, there were six broad areas where barriers were considered but found to be not reasonable. These are explained as follows and include EMM's conclusion on each:

1. NW_M4WB_01 - No receivers achieve an insertion loss of 5 dB with the optimised design height of 5.0 m. The optimised design height eliminates only one property treatment with a 219 m long noise barrier. Therefore barrier is not considered reasonable, so at-property treatments for the triggered receivers are recommended instead of a barrier.

This is considered a reasonable conclusion, however this should be revisited during detailed design given that predicted traffic noise levels for '2031 Build scenario with additional mitigation' are up to 65 dB(A) and 60 dB(A) for the daytime and night time, respectively. Such levels are on the verge of being 'acute', noting that the model has been validated for existing traffic volumes and current design and the lack of any 'factor of safety' in the modelling. The lack of a noise barrier at present provides an opportunity to significantly improve amenity for a cluster of 12 single storey dwellings with the introduction of a new barrier.

2. NW_CCRDPRTAL_01 - No change in the number of triggered receivers for maximum and optimised design height of 8.0 m, and length of 99 m. Only two receivers benefit hence at-property treatments recommended instead of a barrier. To be further considered during detailed design.

This is considered to be a reasonable approach, although this should be revisited during detailed design. The statement that 'only two receivers benefit' is unclear as receivers further back behind such a barrier should also 'benefit'.

3. NW_CONCORD_01A - Maximum and optimised design height of 8.0 m and 1.5 m, respectively. No receivers achieve an insertion loss of 5 dB with the optimised design height. The optimised design height reduces triggers to two-thirds of those that can be eliminated between 0 m and the maximum height barrier. Based on further feasible and reasonable considerations the barrier may prevent access to Sydney Cheil Church and may potentially sterilise future use of the adjacent land by restricting visibility and/or access (between 83-91 Concord Road). Therefore, recommend at-property treatments for the triggered receivers instead of a barrier. To be further considered during detailed design.

If detailed design can resolve stated possible access issues, a barrier in excess of 1.5 m in height should be considered here.

4. NW_SYDNEY_01 - Maximum and optimised design height of 2.5 m. No receivers achieve an insertion loss of 5 dB with the optimised design height. The optimised design height reduces triggers to two-thirds of those that can be eliminated between 0 m and the maximum height barrier. However, based on further feasible and reasonable considerations the barrier may potentially sterilise future use of the adjacent land by restricting visibility and/or access. Therefore, recommend at property treatments for the triggered receivers instead of a barrier. To be further considered during detailed design.

If detailed design can resolve stated possible visible and access issues, a barrier should be considered here.

5. NW_WATTLE_01C,D,E and F - Maximum and optimised design height is 6.5 m and 4.5 m respectively. The optimised design height reduces triggers to two-thirds of those that can be eliminated between 0 m and the maximum height barrier and has benefit to receivers with a mixture of 2 dB and 5 dB insertion loss. However, based on further feasible and reasonable considerations the barrier sections NW_WATTLE_01C to NW_WATTLE_01E (short sections broken by driveway access) are unlikely to be built due to overshadowing and visual impacts. Therefore, recommend at property treatments for the triggered receivers instead of a barrier. To be further considered during detailed design.

It is unclear if NW_WATTLE_01F is included in the proponent's commentary here. Nonetheless, if detailed design can resolve stated possible visible issues, a barrier should be considered here.

6. NW_PARRA_01A and B. For 01A maximum and optimised design height is 6.0 m. Benefiting receivers achieve a mixture of 2 dB, 5 dB and 10 dB insertion loss. However, based on further feasible and reasonable considerations the barrier may potentially sterilise future use of the adjacent land by restricting visibility and/or access. Therefore, recommend at property treatments for the triggered receivers instead of a barrier. To be further considered during detailed design.

If detailed design can resolve stated possible visible and access issues, a barrier should be considered here.

For 01B maximum and optimised design height is 8.0 m and 5.0 m respectively. At the optimised design height the benefiting receivers achieve a mixture of 2 dB and 5 dB insertion loss. However, based on further feasible and reasonable considerations the barrier may potentially sterilise future use of the adjacent land by restricting visibility and/or access. Therefore, recommend at property treatments for the triggered receivers instead of a barrier. To be further considered during detailed design.

If detailed design can resolve stated possible visible and access issues, a barrier should be considered here.

4.2 Fixed noise sources

Fixed noise sources required for the operation of the project include:

- Tunnel jet fan noise from portals;
 - main portals east of Homebush Bay Drive;
 - Concord Road ramps;
 - Wattle Street ramps, south;
 - Wattle Street ramps, north; and
 - Parramatta Road ramps.

- Ventilation buildings;
 - western ventilation building;
 - fresh air supply facility; and
 - eastern ventilation building.
- electrical substations;
- motorway operations complex;
- water treatment facilities; and
- emergency type infrastructure.

4.2.1 Adopted criteria

The EPA's Industrial Noise Policy (INP) was appropriately adopted for assessment of impacts. However, as noted previously, criteria derived from representative background noise levels captured from monitoring locations that are more exposed to ambient noise than others could lead to underestimation of impacts. The additional monitoring, provided by the proponent, noted earlier will resolve this issue satisfactorily. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 condition 26.

The amenity criteria adopted assumes all potentially affected residences are in 'urban' areas as defined in the INP. Clarification should be provided confirming that the adopted INP 'urban' category applies to all areas (eg including further from the motorway) that could potentially be impacted by the fixed plant noise. Future assessments during detailed design must account for receiver categorisation as per the INP. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.1 condition 1, Section 9.6 conditions 27 to 29 and 31 to 33.

Table 25 of the EIS NVIA report lists the $L_{Aeq(Period)}$ Amenity criteria from the INP's Table 2.1 for the night period for urban residences. This criteria applies to all known industrial noise sources affecting a receiver currently and into the future. The assessment should confirm that all industrial noise sources have been considered in the derivation of criteria and therefore the assessment accounts for all industrial sources as required by the INP. The current approach is only valid if no other existing or known future industrial sources contribute materially to noise at receivers. Future assessments during detailed design must account for existing industrial noise as per the INP for receivers further removed from the motorway. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 conditions 27 to 29 and 31 to 33.

The EPA's screening criteria for sleep disturbance assessment has been appropriately identified.

Table 25 of the EIS NVIA report summarises the adopted criteria. These are reproduced in Table 4.2 below. Given the facilities will operate 24 hours a day, the stricter night time criteria is adopted for assessment, which is an appropriate approach.

Table 4.2 Summary of operation noise goals for ventilation facilities

Ventilation facility		Monitor location	Receiver type	Existing night-time noise levels (dBA)		Operation noise goals (dBA)		
Type	Item			RBL	L _{Aeq}	L _{Aeq} (15min) intrusive ¹	L _{Aeq} (period) amenity ^{1,2}	L _{A1} (60sec) sleep dist. screening level
Tunnel Jet Fans	Main portals	L2	Residential	46	54	51	45	61
	Concord Road ramps	L5	Residential	46	62	51	45 ³	61
	Wattle Street ramps – south	L19	Residential	44	69	49	45 ³	59
	Wattle Street ramps – north	L19	Residential	44	69	49	45 ³	59
	Parramatta Road ramps	L15	Residential	41	63	46	45 ⁴	56
Ventilation Buildings	Western ventilation facility	L2	Residential	46	54	51	45	61
	Fresh air supply facility	L10	Residential	46	57	51	45 ⁴	61
	Eastern ventilation facility	L12	Residential	43	56	48	45 ⁴	58

Notes: 1. A grey highlight indicates the controlling design criteria (ie the lower of the intrusiveness and amenity criteria). Further discussion of the intrusive and amenity criteria is provided in Section 9.2.
2. Criteria are identified as controlling as noise source is continuous throughout the period.
3. An urban night-time ANL of 45 dBA has been applied for the amenity criterion at these locations. This is due to the representative of all receivers in the catchment.
4. Locations adjacent to Parramatta Road where road traffic noise levels may decrease in the future due to reduced traffic volumes. An urban night-time ANL of 45 dBA has therefore been applied for the amenity criterion at these locations.

EMM notes the following in respect of the above criteria:

- Main portals and western ventilation facility - adopted logger location L2 which is exposed to the M4 Motorway, having a reported night RBL of 46 dB(A), resulting in an intrusive criterion of L_{Aeq,15min} 51 dB. Given the benefit of subsequent additional data collection post the EIS in response to EMM's Gap Analysis, the criteria should be revised and adoption of ADD03 should be used for properties removed from the motorway. This location shows a night RBL of 37 dB(A), and therefore an intrusive criterion of L_{Aeq,15min} 42 dB. Given the relatively constant character of noise emission from these sources, the recommended criterion is marginally (3 dB) lower than the EIS criterion of L_{Aeq,period} 45 dB.
- Concord Road ramps - adopted logger location L5 having a reported night RBL of 46 dB, resulting in an intrusive criterion of L_{Aeq,15min} 51 dB. Given the benefit of subsequent additional data collection post the EIS in response to EMM's Gap Analysis, the criteria should be revised and adoption of ADD05 should be used for properties removed from Sydney Street. This location shows a night RBL of 39 dB(A), and therefore an intrusive criterion of L_{Aeq,15min} 44 dB. Given the relatively constant character of noise emission from these sources, the recommended criterion is marginally (1 dB) lower than the EIS criterion of L_{Aeq,period} 45 dB.

- Wattle Street ramps - adopted logger location L19 which is exposed to Wattle Street, having a reported night RBL of 44 dB, resulting in an intrusive criterion of $L_{Aeq,15min}$ 49 dB. Given the benefit of subsequent additional data collection post the EIS in response to EMM's Gap Analysis, the criteria should be revised and adoption of ADD13 should be used for properties removed from Wattle Street. This location shows a night RBL of 37 dB(A), and therefore an intrusive criterion of $L_{Aeq,15min}$ 42 dB. Given the relatively constant character of noise emission from these sources, the recommended criterion is marginally (3 dB) lower than the EIS criterion of $L_{Aeq,period}$ 45 dB.
- Parramatta Road ramps - adopted logger location L15 which is exposed to Parramatta Road, having a reported night RBL of 41 dB(A), resulting in an intrusive criterion of $L_{Aeq,15min}$ 46 dB. Given the benefit of subsequent additional data collection post the EIS in response to EMM's Gap Analysis, the criteria should be revised and adoption of ADD14 should be used for properties removed from the road. This location shows a night RBL of 39 dB, and therefore an intrusive criterion of $L_{Aeq,15min}$ 44 dB. Given the relatively constant character of noise emission from these sources, the recommended criterion is marginally (1 dB) lower than the EIS criterion of $L_{Aeq,period}$ 45 dB.
- Fresh air supply facility - adopted logger location L10 which is exposed to Parramatta Road, having a reported night RBL of 46 dB(A), resulting in an intrusive criterion of $L_{Aeq,15min}$ 51 dB. Given the benefit of subsequent additional data collection post the EIS in response to EMM's Gap Analysis, the criteria should be revised and adoption of ADD9 should be used for properties removed from the road. This location shows a night RBL of 41 dB, and therefore an intrusive criterion of $L_{Aeq,15min}$ 46 dB. Given the relatively constant character of noise emission from these sources, the recommended criterion is comparable to the EIS criterion of $L_{Aeq,period}$ 45 dB.
- Eastern ventilation facility - adopted logger location L12 which is exposed to Parramatta Road, having a reported night RBL of 43 dB(A), resulting in an intrusive criterion of $L_{Aeq,15min}$ 48 dB. Given the benefit of subsequent additional data collection post the EIS in response to EMM's Gap Analysis, the criteria should be revised and adoption of ADD13 should be used for properties removed from the road. This location shows a night RBL of 37 dB, and therefore an intrusive criterion of $L_{Aeq,15min}$ 42 dB. Given the relatively constant character of noise emission from these sources, the recommended criterion is marginally (3 dB) lower than the EIS criterion of $L_{Aeq,period}$ 45 dB.
- In all cases, consideration of a suburban classification, in lieu of the adopted urban, should be reviewed and applied where appropriate. An amenity criterion of $L_{Aeq,period}$ 40 dB at night should apply to those receivers considered to be in a suburban environment as defined in the EPA's INP. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.1 condition 1, Section 9.6 conditions 27 to 29 and 31 to 33.

4.2.2 Noise modelling

i Modelling software

It is unclear what modelling software was used, if any, for the prediction of noise levels from fixed plant. Given the use of SoundPlan for both road traffic and construction noise predictions, it is assumed SoundPlan was used for fixed plant modelling. Details and parameters adopted in the modelling are not provided and therefore cannot be reviewed. Of most importance is confirmation that modelling and predictions include effects of prevailing weather in accordance with the INP. This and other details should be provided by the proponent. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 conditions 27 to 29 and 31 to 33.

ii Noise characteristics

The assumption adopted of no adjustment to plant noise (eg fans) due to sound characteristics in accordance with the Industrial Noise Policy (INP) should be justified through supportive data. The spectral frequency data should be provided to justify this assumption and include the predicted spectrum at receivers, not only the at-source spectra as supplied in Table 26. Future assessments during detailed design must account for these characteristics as relevant. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 conditions 27 to 29 and 31 to 33.

iii Ventilation facilities

A prediction of potential ventilation facility noise impacts has not been provided. It is stated that details are not yet available to be able to predict and assess impacts from such sources. In lieu of this, specifications for plant has been established based on derived noise criteria at receivers. This is not considered to be good practice. Emission values for similar plant from similar projects should be used to estimate the potential for impacts. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 conditions 27 to 29 and 31 to 33.

4.2.3 Results

Only tunnel jet fan noise predictions are provided. Noise from other fixed plant are not provided including ventilation facilities, motorway operations complex, electricity substations, water treatment facilities and emergency type infrastructure (which is less of an issue given these do not operate normally or regularly).

It would appear that all omissions have been deferred to the detailed design stage of the project, given the lack of current details, and this should occur at the earliest time possible.

The predicted noise levels from fixed plant should include noise contours and not just at one representative location within each NCA as provided for tunnel jet fan noise. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 conditions 27 to 29 and 31 to 33.

i Tunnel jet fan noise

Tunnel jet fan noise predictions are shown to satisfy adopted noise criteria at all sites. Review of such predictions against revised criteria described in Section 4.2.1 also indicates criteria should be satisfied.

The predicted received noise levels in Table 27 should include additional detail for adopted loss factors. For example, main portals jet noise is predicted to be 37 dBA (at the nearest residence). Earlier the report states the model assumes four jet fans located 50m inside the tunnel and that main portals are 25 m from the nearest residence. The sound power level in Table 26 (109 dBA) converts to 115 dB(A) for four fans, reducing to 70 dBA at 75m (50m inside the tunnel plus 25m to the residence from the tunnel portal) based on standard point source distance loss only.

Hence, there is a further loss of 33 dB (70 less the predicted 37) due to unexplained factors (these could be tunnel lining, barrier, air absorption or other) that should be provided as this is a significant amount of energy loss. A detailed large scale diagram or graphic showing relative locations of fans, portal and receivers should be provided to assist in demonstrating factors influencing these predictions. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 condition 26.

ii Ventilation facilities

As noted earlier, only specifications for emission values have been provided for potential noise from ventilation facilities. The specified sound power levels (ie at source emission) are:

- western ventilation facility - $L_{Aeq,15min}$ 81 dB;
- fresh air supply facility - $L_{Aeq,15min}$ 76 dB; and
- eastern ventilation facility - $L_{Aeq,15min}$ 84 dB.

The above were derived essentially by backward calculating from adopted noise criteria for the nearest residences. These are considered to be minimum specifications and must account for annoyance characteristics as per the INP (ie they may need to absorb penalties of 5 dB or more).

The revised noise criteria described in Section 4.2.1 means the above specifications must be altered to the following (or lower values if further monitoring shows it is appropriate):

- western ventilation facility - $L_{Aeq,15min}$ 78 dB;
- fresh air supply facility - $L_{Aeq,15min}$ 76 dB (unchanged); and
- eastern ventilation facility - $L_{Aeq,15min}$ 81 dB.

The above revised sound power level specifications were reviewed against similar facility emission values contained in the WestConnex New M5 and NorthConnex road projects. The following is found:

- WestConnex New M5:
 - Ventilation facilities - 126 dB, 121 dB and 122 dB reducing to 83 dB, 75 dB and 76 dB using attenuators; and
 - Fresh air intake - 133 dB and 135 dB reducing to 88 dB and 76 dB using attenuators.
- NorthConnex:
 - Ventilation facility - 121 dB reducing to 68 dB using attenuators; and
 - smoke extraction facility - 125 dB reducing to 69 dB using attenuators.

The above shows that sound emission values needed to satisfy noise criteria at residences cannot be achieved without heavy reliance on high performance attenuators. The insertion losses quoted in both WestConnex New M5 and NorthConnex are substantial and the noise reports for each project do not provide source information for such attenuators (eg published manufacturer data of typically available systems). Furthermore, attenuators will likely cause received noise levels to be defined as low frequency such that the INP's 5 dB penalty would apply. This is because attenuators reduce mid to higher frequency more than lower frequency.

The final sound power levels post attenuators indicate that the required WestConnex M4 East specifications can be satisfied using careful design and assuming stated attenuator losses can be achieved.

The onus will be on the proponent to ensure appropriate criteria at residences are satisfied. The setting of noise criteria at receivers will be addressed through appropriate conditions of consent, assuming the DP&E grant approval, to ensure the community is protected in accordance with relevant government noise policy. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 condition 26.

4.2.4 Noise management and mitigation

A review of the EIS NVIA noise management and mitigation measures was completed for its adequacy and appropriateness.

The study identifies the following for fixed plant:

- building fabric housing the ventilation equipment is such that it ensures breakout noise is at least 10 dB lower than the ventilation outlet. EMM agrees that this requirement can be readily satisfied.
- specification of sound power levels for ventilation facilities. Although no noise mitigation is specifically stated, it is apparent that significant reliance will be needed on high performance attenuators to ensure receivers are appropriately protected.

As stated earlier, other facilities have not been addressed and have been deferred to the detailed design stage. This is not unusual for such projects, however such details and any required noise management and mitigation should be completed at the earliest time possible. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 condition 26.

5 Noise and vibration during construction

5.1 Adopted criteria

The Secretary's Environmental Assessment Requirements (SEARs) nominate the Department of Environment Climate Change and Water (DECCW) Interim Construction Noise Guideline (ICNG) (DECCW 2009) and the Department of Environment and Conservation (DEC) Assessing Vibration: a technical guideline (DEC 2006) for the assessment of construction noise and vibration. The EIS NVIA report appropriately references these documents.

The SEARs also require consideration of *"the nature of construction activities (including transport, tonal or impulsive noise-generating works and the removal of operational noise barriers, as relevant), the intensity and duration of noise and vibration impacts, the nature, sensitivity and impact to potentially affected receivers, the need to balance timely conclusion of noise and vibration-generating works with periods of receiver respite, and other factors that may influence the timing and duration of construction activities (such as traffic management), and mitigation and management measures. The assessment should present, as relevant, an indication of potential for works outside standard working hours, including predicted levels and exceedences, justification for the activity and discussion of available mitigation and management measures."*

The above has been considered throughout the EIS NVIA report.

Additional relevant standards and guidelines were also adopted in accordance with good practice. These include:

- EPA's current sleep disturbance recommendation;
- RNP sleep disturbance guidance;
- Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZEC), 1990;
- AS 2187: Part 2-2006 Explosives - Storage and Use - Part 2: Use of Explosives, Standards Australia, 2006;
- BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2, BSI, 1993;
- DIN 4150:Part 3-1999 Structural vibration - Effects of vibration on structures, Deutsches Institute fur Normung, 1999; and
- Construction Noise Strategy, TfNSW, 2012.

As noted earlier, additional noise monitoring completed since the EIS NVIA report will mean that stipulated construction noise management levels (NMLs) must be revised as appropriate.

5.2 Noise modelling

5.2.1 Adopted software

The modelling software adopted was SoundPlan 7.1 incorporating concept design of the proposal, local terrain, receiver buildings and structures digitised in the noise model to develop a three-dimensional representation of the construction sites and surrounding environment.

Details on the modelling parameters have not been provided, including whether predictions are for calm or adverse weather conditions. Such details should be provided. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 condition 26.

5.2.2 Sound emission levels

Table 31 provides 'Sound Power Level (dBA)' by 'item', 'activity' and 'LWAmx activity'. Explanations or definitions of each of these terms should be provided. The addition of the items for some scenarios matches the 'activity', yet for other scenarios matches the 'LWAmx activity' and therefore indicating a possible inconsistency in the approach requiring clarification.

Further appropriate clarification on the above has since been provided by the proponent in response to EMM's Gap Analysis.

Table 31 nominates open-ended durations for example '> 6 months'. An upper estimate of such works should be provided, eg '>6months to 18 months' to better inform the community.

It is stated that for activities identified as particularly annoying (such as jackhammering, rock breaking and power saw operation), a 5 dBA 'penalty' is added to predicted noise levels in accordance with the EPA ICNG. This is considered to be appropriate although specific details are not provided.

5.3 Results

5.3.1 Airborne noise

Predictions of worst case construction noise have been provided for the nearest and most affected receiver and receiver type in each NCA. A range is provided being that for the noisiest and least noisiest construction scenario. Noise contours showing NML exceedances are also provided at Appendix R of the EIS NVIA report.

It is clearly demonstrated that significant noise level exceedances are expected due to the project and across many areas of works. This is not unexpected and is almost inevitable for such construction works given proximity of receivers. The exceedances occur during standard hours, including exceedance of the ICNG highly noise affected target of 75 dB $L_{Aeq,15min}$, and during out of hours works, including exceedance of night time sleep disturbance targets.

The EIS NVIA at tables 32 to 45 provide the predicted construction noise level range for worst affected and median exceedances of NMLs and sleep disturbance assessment for residences in each NCA for seven different construction stages. These predictions show the following:

- work area establishment (1 to 4 weeks duration) - as a worst case, 20 of the 21 NCAs are expected to experience noise levels up to and above the ICNG highly noise affected level of 75 dB $L_{Aeq,15min}$, while median noise levels are expected to exceed 75 dB at one of the 21 NCAs (ie NCA08);

- temporary road and intersection modifications (2 to 4 weeks duration) - as a worst case, one of the 21 NCAs are expected to experience noise levels up to and above the ICNG highly noise affected level of 75 dB $L_{Aeq,15min}$, while median noise levels are not expected to exceed 75 dB. Median noise levels are expected to satisfy NMLs at most NCAs, with a marginal (1 dB) exceedance at one NCA (NCA08);
- construction ancillary facilities: general worksites (6 to 8 weeks or duration of works) - as a worst case, 15 of the 21 NCAs are expected to experience noise levels up to and above the ICNG highly noise affected level of 75 dB $L_{Aeq,15min}$, while median noise levels are expected to exceed 75 dB at one of the 21 NCAs (ie NCA08);
- roads/cut-and-cover/dive structures and approach roads and ramps (2 to 8 weeks duration) - as a worst case, 19 of the 21 NCAs and receivers east of works limit are expected to experience noise levels up to and above the ICNG highly noise affected level of 75 dB $L_{Aeq,15min}$, while median noise levels are expected to exceed 75 dB at three of the 21 NCAs (ie NCA01, 08 and 15);
- tunnelling site operations, including excavation and ground support, civil, mechanical, and electrical (greater than 6 months or duration of works) - as a worst case, five of the 21 NCAs are expected to experience noise levels up to and above the ICNG highly noise affected level of 75 dB $L_{Aeq,15min}$, while median noise levels are not expected to exceed 75 dB;
- demolition of acquisition properties (4 to 8 weeks duration) - as a worst case, 16 of the 21 NCAs are expected to experience noise levels up to and above the ICNG highly noise affected level of 75 dB $L_{Aeq,15min}$, while median noise levels are expected to exceed 75 dB at three of the 21 NCAs (ie NCA08, 14 and 15);
- ventilation facilities construction (8 to 12 weeks or duration of works) - worst case and median noise levels are not expected to be above the ICNG highly noise affected level of 75 dB $L_{Aeq,15min}$; and
- A summary of highly noise affected receiver numbers is provided in Table 46 of the EIS NVIA report and this is reproduced in Table 5.1. As per the ICNG, residences are considered to be highly noise affected if noise levels from construction exceed 75 dB $L_{Aeq,15min}$. This relates to daytime works only.

Table 5.1 **Summary of highly noise affected residential receivers**

Scenario	Number of worst-case highly noise affected residential receivers ¹																				
	NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07	NCA08	NCA09	NCA10	NCA11	NCA12	NCA13	NCA14	NCA15	NCA16	NCA17	NCA18	NCA19	NCA20	NCA21
Work area establishment - All Areas	7	43	14	22	8	21	11	8	15	-	10	15	5	26	34	15	21	19	3	11	38
Temporary Road and intersection modifications	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Construction ancillary facility – General Worksites	2	9	-	7	1	6	-	6	-	-	1	3	4	3	11	6	5	4	-	-	20
Roads/Cut-and-cover/Dive Structures and Approach Roads and Ramps	14	41	33	18	8	27	19	8	23	-	7	-	4	19	39	18	49	31	7	28	43
Tunnelling site operations, including Excavation and ground support, civil, mechanical, and electrical	-	-	-	1	-	-	2	1	2	-	-	-	-	2	-	-	-	-	-	-	-
Demolition of acquisition properties	-	5	-	30	1	23	19	8	22	-	5	-	10	35	38	13	14	34	1	11	52
Ventilation facilities Construction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes: 1. Count is based on the total number of receiver buildings predicted to be subject to worst-case construction noise levels above the highly noise affected level (75 dBA) at any time in the entire construction schedule. This is generally limited to periods when noise intensive activities are located immediately adjacent to residences. It is therefore expected that the number of noise affected receivers on a typical day to day basis would be considerably less than presented in this table. Note that the ICNG definition of 'highly noise affected' applies to the standard construction (daytime) period only– refer to Table 28.

The information presented in Table 5.1 indicates that worst case construction works are expected to result in daytime noise levels above 75 dB $L_{Aeq,15min}$ during noise intensive activities at worst affected residences during the works.

It is noted that the above results will need to be reviewed in the detailed design stage to take into account the additional monitoring data as described earlier. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6.

Site-specific construction noise and vibration management plans (CNVMPs) are recommended in the detailed design phase when more information is available on the schedule for the works and the equipment to be used. The proponent and construction contractor(s) should schedule work (where necessary) to provide respite periods from the noisiest activities, and communicate with the impacted residents by clearly explaining the duration and noise level of the works.

Where out of hours works (OOHWs) are required the proponent should identify all feasible and reasonable work practices in the CNVMPs to reduce potential noise impacts. Where all feasible and reasonable practices have been applied and noise would be more than 5 dB above the noise affected level, the proponent should negotiate with the community to determine the schedule for the works or provide respite to occupants where sleep disturbance is likely to occur.

5.3.2 Construction road traffic noise

Road traffic noise impacts are expected for residences of local roads Short Street (daytime and night time) and Powell Street (daytime) due to heavy vehicles needed for civil works. Noise level increases at all other roads proposed for use during construction are expected to satisfy RNP 'allowable increase' criteria.

5.3.3 Ground borne noise

Roadheaders proposed for use during tunnelling are expected to cause exceedance of ground-borne noise level criteria at residences located within 30m of works during the night time and within approximately 18 m during the daytime.

Exceedances of up to 10 dB of the night time 35 dB(A) criteria is indicated for residences within 10m of tunnelling. This is expected to occur at locations in the vicinity of the Concord Road, Concord access ramps to and from the M4 East tunnels. These night time exceedances are expected to extend over a period of approximately 10 days. Other areas expected to exceed night time criteria include Parramatta Road Ashfield where the main tunnels become shallower and ground borne noise levels of up to 43 dB are predicted for a period of approximately six days.

Also, exceedances of night time criteria are predicted for properties in the vicinity of Wattle Street where levels of up to 53 dB are expected, and therefore significantly above both daytime (40 dB) and night time (35 dB) criteria. Such exceedances are expected over a period of two weeks. Marginal (2 dB) exceedances of the night time criteria are predicted for residences in the vicinity of Burwood Road, Burwood.

Other activities that are expected to generate ground borne noise are the use of rockbreakers for excavation of benches and cross passages within tunnel sections of the project. Exceedance of the night time criterion is expected for all such activities, with daytime criterion values satisfied when works are more than 40m from receivers.

The EIS appropriately considers management and mitigation measures for ground borne noise as described later.

5.3.4 Vibration

The EIS NVIA report provides safe working distances for vibration intensive plant along with the number of buildings within such distance for each NCA.

If a relatively large rockbreaker were used, exceedances of cosmetic damage targets are predicted for 203 residential and light commercial buildings, 238 residential buildings, 13 heritage (structurally unsound) buildings and exceedance of human response criteria at 493 buildings.

The EIS recommends vibration trials and attended monitoring prior to and during works proposed within safe working distances. This is considered to be an acceptable and practical approach.

5.3.5 Blasting

Blasting is proposed to assist in the development of tunnel benches and cross passages as an excavation technique. Adopted ground vibration annoyance criterion of a maximum 10mm/s is expected to be exceeded for a tunnel depth of 30m or less, which is typical or higher for the project. Reducing the maximum instantaneous charge (MIC) would reduce impacts and is a common way to control blast affects.

5.4 Noise management and mitigation

Since the EIS, a CNVMP has been drafted for discussion with agencies and councils. The draft CNVMP was provided separately to EMM subsequent to the Submissions Report. The draft CNVMP adopts a contemporary approach and is based on the DP&E's standard and model conditions for linear infrastructure. The plan includes a set of revised environmental management measures for noise and vibration (NV1 to NV42) and noise and vibration mitigation and management measures (NVM1 to NVM30) and how these would be implemented. The draft plan also includes Roads & Maritime Design & Construct G36 specification which identifies environmental safeguards and management measures or conditions the project must satisfy. The plan also adopts Transport for NSW (TfNSW) construction noise strategy (2012). Furthermore, consultation with the EPA forms an integral part of the draft plan. Importantly, the draft plan at Appendix C includes an out of hours work protocol. EMM has reviewed the draft CNVMP and notes that the management measures are consistent with those documented in the submissions report.

The revised environmental management measures are listed in the Response to Submissions and are reproduced in Table 5.2.

Table 5.2 **Revised environmental management measures from the M4 East Submissions Report relevant to the management of noise and vibration**

	No.	Revised environmental management measure
Construction - General	NV1	A construction noise and vibration management plan(s) will be prepared and implemented consistent with the requirements of the Interim Construction Noise Guideline (DECC, 2009), and will include the following: • Identification of nearby residences and other sensitive land uses. • Description of approved hours of work. • Description and identification of construction activities, including work areas, equipment and duration. • Description of what work practices (generic and specific) will be applied to minimise noise and vibration. • A complaints handling process. • Noise and vibration monitoring procedures. • Overview of community consultation required for identified high impact works.
Construction noise	NV2	Induction and training will be provided to relevant staff and subcontractors outlining their responsibilities with regard to noise.
	NV3	Surface work will be undertaken during standard construction hours as far as feasible and reasonable.
	NV4	Where feasible and reasonable, particularly noisy activities such as the use of impact piling rigs, road and concrete saws and rockbreakers, will be scheduled around times of high background noise to provide masking.
	NV5	Noisy activities that cannot be undertaken during standard construction hours will be scheduled as early as possible during the evening and/or night-time periods.
	NV6	Particularly noisy activities will be scheduled during the less sensitive times of 9.00 am to 12.00 pm or 2.00 pm to 5.00 pm where appropriate, or in accordance with the environment protection licence.
	NV7	Permanent noise barriers will be scheduled for completion as early as possible in order to minimise construction noise.
	NV8	Property treatments identified for the operational phase of the project will be considered for installation as early as possible, where they would improve construction noise levels.
	NV9	Acoustic sheds to be erected at the Underwood Road tunnel site (C3), Concord Road tunnel site (C5), Cintra Park tunnel site (C6) and Northcote Street tunnel site (C7) will be reviewed during construction planning to determine the attenuation level required.
	NV10	Temporary acoustic barriers (walls or hoarding) will be considered at all construction ancillary facility and work areas where feasible and reasonable. Recommended heights and locations of these barriers are provided in Table 42 of the noise and vibration assessment in Annexure J of the EIS.
	NV11	Night works, other than tunnelling, will be programmed to minimise the number of consecutive nights that work affects the same receivers.
	NV12	When working adjacent to schools, particularly noisy activities will be scheduled outside normal school hours, where practicable.
	NV13	Works will be scheduled to avoid the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers.
	NV14	Equipment that is used intermittently will be shut down when not in use.
	NV15	Where feasible and reasonable, heavy vehicle movements which are utilised for surface works will be limited to daytime hours.

Table 5.2 **Revised environmental management measures from the M4 East Submissions Report relevant to the management of noise and vibration**

	No.	Revised environmental management measure
	NV16	Where feasible and reasonable, the offset distance between noisy plant items and nearby noise sensitive receivers will be as large as possible.
	NV17	Where feasible and reasonable, equipment with directional noise emissions will be oriented away from sensitive receivers.
	NV18	Regular compliance checks on the noise emissions of plant and machinery will be conducted.
	NV19	Ongoing noise monitoring will be undertaken during construction at sensitive receivers during critical periods to identify and assist in managing high risk noise events.
	NV20	Reversing of equipment will be minimised to prevent nuisance caused by reversing alarms. Use of non-tonal reversing alarms ('quackers') will be implemented to further reduce the nuisance caused by reversing alarms.
	NV21	Loading and unloading will be carried out away from sensitive receivers, where practicable.
	NV22	Delivery of materials will be carried out during standard construction hours where feasible and reasonable, or as required by NSW Police or other authorities for safety reasons.
	NV23	Alternative works methods, such as use of hydraulic or electric controlled units in place of diesel units, will be considered and implemented where feasible and reasonable.
	NV24	Respite periods (eg one hour respite for every three hours of continuous construction activity) will be scheduled for high noise impact works where appropriate.
Construction traffic noise	NV25	Truck drivers will be advised of designated vehicle routes, parking and queuing locations, acceptable delivery hours and other relevant practices (i.e. minimising the use of engine brakes, and no extended periods of engine idling).
	NV26	Should the second storey of buildings at construction ancillary facilities be proposed to be used for any purpose other than site offices and amenities, and particularly where plant and equipment would be used, additional noise assessment will be undertaken.
	NV27	Deliveries and spoil removal will be planned to avoid queuing of trucks around construction ancillary facilities.
	NV28	As far as practicable, construction vehicle movements along local roads at night will be restricted to light vehicles only, subject to further investigation of potential night-time maximum noise levels during detailed design.
	NV29	As far as practicable, heavy vehicle movements outside standard construction hours associated with tunnel support works (spoil removal, concrete delivery and other heavy vehicle movements) will be limited to access and egress directly to and from the arterial road network.
	NV30	Spoil removal will be minimised between 10.00pm and 7.00am.
Construction vibration	NV31	Building condition surveys will be undertaken on properties and structures located: - Within the preferred project corridor (the zone on the surface equal to 50 metres from the outer edge of the tunnels). - Where potential for exceedances of the blasting criteria is identified. - Within 50 metres of surface works. Building condition surveys of potentially affected structures will be completed both before the start of tunnelling or other vibration intensive works and after completion of works, to identify existing damage and any damage due to the works.
	NV32	The safe working distances will be complied with where feasible and reasonable. This will include the consideration of smaller equipment when working close to existing structures.

Table 5.2 **Revised environmental management measures from the M4 East Submissions Report relevant to the management of noise and vibration**

	No.	Revised environmental management measure
	NV33	If vibration intensive works are required within the safe working distances, vibration monitoring or attended vibration trials will be undertaken at the outset of these works to ensure that levels are within relevant criteria.
	NV34	Investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment to less sensitive times such as 9.00 am to 12.00 pm or 2.00 pm to 5.00 pm, where appropriate, or in accordance with the environment protection licence.
	NV35	Investigations will be undertaken into all heritage items located within the safe working boundary to determine if these structures are structurally unsound, to assist with determining the applicable criteria for each item.
Ground borne noise	NV36	Vibration intensive construction works will be confined to the less sensitive daytime period (9.00 am to 12.00 pm and 2.00 pm to 5.00 pm) as far as reasonably practicable, or in accordance with the environment protection licence.
	NV37	A detailed ground-borne noise assessment will be undertaken following further geotechnical investigations. This will include developing the vibration site law for the project.
Blasting	NV38	Noise and vibration mitigation methods specific to blasting will be incorporated into the construction noise and vibration management plan where required.
	NV39	Blasting will be restricted to standard daytime hours (except where approved by the relevant authority).
	NV40	Site investigations will be conducted prior to production blasting to define suitable blast sizes to comply with project blasting noise and vibration criteria.
	NV41	Where the predicted levels exceed the noise or vibration criteria for blasting, alternative construction methods, such as penetrating cone fracture, will be utilised.
Operational ventilation facility	NV42	Once plant items within the ventilation facility confirmed during detailed design, impacts will be assessed with consideration of the Industrial Noise Policy (INP) modifying factors. Where modifying factors are found to be applicable they will be added to the assessment, and compliance with the INP criteria checked at all receivers.
Consultation with impacted receivers	NV43	Community consultation protocols for sensitive receivers likely to be impacted by construction activities such as blasting, vibration and noise will be prepared and implemented.
Road noise impact	OpNV 1	At locations where residual impacts remain after all feasible and reasonable approaches have been exhausted, noise mitigation in the form of acoustic treatment of existing individual dwellings will be considered.
	OpNV 2	Noise barriers will be refined during detailed design to maximise the number of receivers that receive a reduction in exceedances of noise criteria.
	OpNV 3	Within 12 months of commencement of operation, operational traffic noise will be monitored at sensitive receivers to compare actual noise performance of the project against predicted noise performance. If the traffic noise levels are above the predicted levels, consideration of additional feasible and reasonable mitigation measures will be undertaken.
Operational ancillary facilities	OpNV 4	Operational ancillary facilities will be designed to meet project specific noise criteria derived in accordance with the NSW Industrial Noise Policy.

6 Gap analysis

The following section provides a gap analysis of the noise and vibration report in the EIS. A response to the gap analysis has been provided by the proponent and is shown in Appendix C of this report, together with final review comments by EMM. The section references below relate to the Noise Technical Report in the EIS.

1. Section 3 Description of the existing environment

The adopted noise catchment areas (NCAs) are large and a single noise monitoring location is used within each NCA to represent the whole acoustic climate therein. The monitoring locations are used to serve two purposes. That is, to establish background noise for setting appropriate criteria for construction and fixed plant noise assessment, and to establish the existing level of traffic noise for assessment of future traffic noise impacts. Noise monitoring for these two purposes often has conflicting monitor positioning requirements. This could lead to shortcomings in the impact assessment of construction and fixed plant noise, as often the monitoring location is the closest to the main roadway nearby (eg existing M4 alignment) and not further away where background noise levels will be lower. While traffic noise reduces by 3 dB per doubling of distance and construction or fixed plant by 6 dB per doubling of distance, accounting for shielding due to barriers or buildings could lead to greater reductions of traffic noise at say beyond two rows of houses from the road. This level of attenuation is not necessarily the same for construction sites and fixed plant sources (which could be considerably elevated as per the ventilation building for example).

Table 8 confirms via attended noise monitoring and observations that most monitoring locations were in environments dominated by heavy traffic noise from roads. Appendix C maps and photographs also confirm that monitors were positioned on property boundaries closest or most exposed to the M4 motorway or other road nearby, which ensures the monitors represent the noisiest position for the individual property and the whole NCA. For some locations (eg L5) the microphone is not in a free field environment as required for RBL determination for the purposes of construction and fixed plant noise impact assessment. The positioning of most of the monitors are suitable for traffic noise impact assessment and therefore possibly unsuitable for construction noise impact assessment. There are some exceptions to this whereby the monitors are positioned in locations specifically to address construction noise from proposed nearby compounds or work sites.

The data in Appendix C demonstrates that RBL values are significantly lower when measurements are completed at locations further away from major roads. While relationships between distance from roadways and RBL values may not be possible, it is clear that consistently quieter areas exist away from main roads. For example, the data from four nearby monitoring stations presented in Appendix C show the two that are not exposed to the M4 or Parramatta Road are afforded a lower and the same daytime RBL of 41 dB (L7 and L9), while the other two (L6 and L8) RBLs are 48 dB and 55 dB respectively. That is, a considerable 14 dB difference in daytime RBL is measured between L8 to L7 or L9. This difference is not as significant, but still material at up to 7 dB (L8 to L9), at night when traffic volumes are lower. It is therefore plausible that other NCAs where single monitoring locations are used to represent the entire NCA for the purposes of construction noise impact assessment could lead to underestimation of impacts.

The requirements for noise monitoring for the two purposes are stipulated in the ICNG (and INP) and RNP for construction (and operation) and road traffic noise respectively. The approach should also not result in overly conservative outcomes where RBL monitoring positions are less exposed to the chosen assessment location. An appropriate and representative balance needs to be achieved.

2. Section 5.2 Road noise prediction algorithms

It is acknowledged that the adopted SoundPlan version 7.1 noise modelling software has been updated and is now at version 7.4. The NVIA states that since version 7.1, SoundPlan has not been verified for use on large infrastructure projects, and so newer versions have not been used. An explanation of differences between the two versions that could alter predicted levels, if relevant, should be provided. Alternatively, it should be confirmed that the calibration undertaken for the project model nullifies any such potential differences.

3. Section 5.4.7 Noise model validation corrections

The complexity of how corrections to predicted noise levels from congestion during the night period (10pm to 7am) are determined should be clarified, particularly when volumes would be appreciably lower than daytime. Table 11 indicates that the noise model underestimates free flowing traffic noise (Step 1) more often than not (17 of 24 predictions are underestimates). However, predictions for whole assessment periods (Step 2) overestimate more often than not (9 of 24 predictions are underestimates). The differences between Steps 1 and 2 are said to be related to traffic congestion factors. It would be valuable to show the measured noise levels for the free-flowing hours (Step 1) to better understand this process and possible difference between Step 1 and Step 2. Of particular interest is the M4 night congestion factor where a minus 2.1 (overestimation) median correction is determined. This logic should be further explained as it is not clear why for example Step 2 is not the model's validation factor for the period. The latter would give rise to a median validation factor for the M4 of minus 1.3 dB (ie overestimation by the model) as opposed to the adopted 2.1.

Expanding further on this and looking closely at logger location L23, through an analysis of measured $L_{eq,night}$ noise levels (Table 13) and traffic volumes provided in Appendix F, an estimate of the free-flowing traffic noise level is determined to be 48 dBA. At this location, a night RBL of 49 dBA and L_{eq} of 57 dBA is presented at Appendix C. The charts show that L_{eq} noise levels do not drop below 51 dBA at night between midnight and 4am. These levels of ambient L_{eq} and background noise level could influence 'measured' traffic noise used to develop corrections in the model. Such issues should be investigated to determine whether they affect (conservatively or non-conservatively) the final correction factors used in the assessment.

4. Table 12 congestion corrections for Parramatta Rd and Wattle St appear to follow conflicting logic based on statistical significance of speed corrections (Step 3 in Table 11). For Parramatta Rd it is stated that there is 'negligible congestion on basis of speed' while for Wattle St it is stated that there is 'marginal congestion on basis of speed'. Yet Table 11 at Step 3 for night-time shows differences of -0.2 for Wattle St, the same value as shown for Parramatta Rd daytime differences. This should be explained as the implication could be that the correction value that should be adopted for Wattle St is nil and not -1.4 dB. Such correction factors although marginal, can result in a material difference in the number of properties afforded treatment as demonstrated at Figure 11 at Section 8.6 'Sensitivity analysis' (eg for 1 dB increase in predictions the number of properties eligible for at house mitigation increases by 51).

5. Section 5.4.8 Model validation summary

There are five entries in each of the two night time 'differences' columns (ie 10 entries total) that are out by 0.1 dB. This should be explained (eg rounding errors etc.) and whether this alters the developed congestion corrections.

6. It is unclear whether the median difference between predicted and measured from Table 13 is applied globally to all roads, locations and periods or if the individual differences specific to each road, location and period were used later in the predicted levels. A note is provided beneath Table 16 (Note 4) at Section 5.15 that describes this, but further clarification is needed.

7. Section 5.6 Modelling of traffic data

The traffic volume data referred to (and provided at Appendix F) has not been specifically referenced from the Traffic and Transport assessment report. The Traffic and Transport report contains AM and PM peak volumes, ADT and AWT volumes for the M4, but not daytime 15-hour and night 9-hour volumes, nor volumes for free-flowing hours as adopted in the noise assessment. The traffic volume data should be appropriately referenced or sourced and assumptions used to derive volumes adopted in the noise assessment should be provided (eg how was 15-hour and 9-hour volumes for 'No build' and 'Build' cases derived from AWT data in the traffic assessment).

8. Section 5.11 Roads modelled in the assessment

It appears that the M4 carriageway west of Homebush Bay Dr was not modelled for this project. It is understood that this was assessed as part of the M4 Widening project. However, it is unclear if the M4 Widening project accounted for traffic volumes as a consequence of the current project and others part of the WestConnex scheme. This section of road will likely see a change in traffic volume due to the current project, and residences to the south in the vicinity of the project boundary at this location could be affected. This issue should be clarified.

9. Section 5.13 Receiver counts

The statement relating to multi-level residential buildings and at property treatment applying to ground and first floor levels only is not entirely consistent with the Road Noise Policy (RNP). The RNP states at Table 7 "The external points of reference for measurement are the two floors of the building that are most exposed to traffic noise". In most cases the ground and first floors could be the most exposed. It is understood that this level of scrutiny is not feasible at this stage of the project, but if possible the assessment should identify where potential exists for other floors to be worst affected if relevant. Alternatively confirm that all 'most affected' two floors are the ground and first floor, or otherwise note that this will be the approach adopted in detailed design and in likely consent conditions should approval be granted.

10. Section 8.1 Operational noise impacts without mitigation

Noise contours for the M4 East alone should be provided (notwithstanding Appendix J) along the route for all cases modelled for $L_{eq,15hr}$ and $L_{eq,9hr}$. These contours will provide the reader with valuable graphic representation of 'No Build' vs 'Build' scenarios, particularly for the most exposed facade to the M4 alignment.

11. Section 8.1.2 Receivers considered for additional noise mitigation

This section is unclear with regard to the total number of receivers requiring additional mitigation. The figures of 76, 33 and 283 quoted to receive treatment total 392 (consistent with Table 18), however the overall total quoted is 400. Further clarification should be provided in respect of the 400 figure.

12. Section 8.4 Operational noise impacts with mitigation

It is stated that Appendix N tabulates predicted noise levels for all assessed locations. The table should include a legend identifying the various column headings that are abbreviated (eg T1_NB_D_RND and T1_FB_D_RND - this and other column headings are not totally clear and should be clarified).

13. It is unclear if all assessed locations are listed in Appendix N. For example, NCA01 locations do not include 14 Welfare Street and 2 Flemington Road. These properties are located between the M4 and Parramatta Road and therefore within the assessment zone. Predictions are shown for these properties at Appendix M maps. This should be explained or these locations (and others as relevant) added to Appendix N.

14. It is unclear if all assessed locations are listed in Appendix N. For example, NCA01 locations do not include 14 Welfare Street and 2 Flemington Road. These properties are located between the M4 and Parramatta Road and therefore within the assessment zone. Predictions are shown for these properties at Appendix M maps. This should be explained or these locations (and others as relevant) added to Appendix N.

15. A similar table to that in Appendix N should be provided for the M4 project alone as received at the most exposed facade of dwellings to understand its contributions for the various options and the two years modelled. The presented results with respect to number of properties above or below criteria for build cases is skewed (when compared to no build) given the benefits of reduced traffic noise from a large section of Parramatta Road.

16. Section 8.7 Maximum noise levels

Discussions on typical increases in maximum noise levels is provided as a range of increases from 2 dBA to >10 dBA for six of the adopted NCAs. The upper end of the increases should be provided rather than an open ended >10 dBA reference.

17. Section 9 Ventilation facilities noise impact assessment

This section requires additional detail to better contextualise the fixed sources and their closest receivers. In a typical industrial noise impact assessment, the 'site' would be detailed in a figure at a reasonable scale showing the specific location of noise items relative to the site boundary and its neighbours.

18. The above would then allow for a better justification to be constructed of whether the chosen representative assessment location and its representative logger location are appropriate (eg for developing noise criteria in accordance with the INP). This item relates back to Item 1 in this table and is particularly relevant to the ventilation facilities. That is, with a source 25m or 30m above ground, will the selected logger provide a representative background noise level for assessment of the potentially most exposed receivers.

19. Section 9.2.3 Modifying factor adjustments

The assumption adopted of no adjustment to plant noise (eg fans) due to sound characteristics in accordance with the Industrial Noise Policy (INP) should be justified through supportive data. Supportive spectral frequency data should be provided to justify this assumption and include the predicted spectrum at receivers, not only the at-source spectra as supplied in Table 26.

20. Section 9.4 Noise goal summary

As above and Item 1, the RBL and derived intrusive criteria in Table 25 should be revisited.

21. The amenity criteria adopted assumes all potentially affected residences are in 'urban' areas as defined in the INP. Justification should be provided as to why the INP 'suburban' category does not apply to some areas (eg further from the motorway) that could also be impacted by the fixed plant noise.

22. Table 25 lists the $L_{Aeq(Period)}$ Amenity criteria from the INP's Table 2.1 for the night period for urban residences. This criteria applies to all known industrial noise sources affecting a receiver currently and into the future. The assessment should confirm that all industrial noise sources have been considered in the derivation of criteria and therefore the assessment accounts for all industrial sources as required by the INP. The current approach is only valid if no other existing or known future industrial sources contribute to noise at receivers.

23. Note 3 to Table 25 concedes that "...noise logging locations being adjacent to the road which results in the measured L_{Aeq} noise levels not being representative of all receivers in the catchment." This highlights the potential issue at Item 1.

24. Section 9.7 Predicted noise impacts

The predicted noise levels from fixed plant should include noise contours as provided for construction sites.

25. The predicted received noise levels in Table 27 should include additional detail for adopted loss factors. For example, main portals jet noise is predicted to be 37 dBA (presumably at the nearest residence). Earlier the report states the model assumes four jet fans located 50m inside the tunnel and that main portals are 25 m from the nearest residence. The sound emission factor in Table 26 (109 dBA) converts to 115 dBA for four fans, reducing to 70 dBA at 75m (50m inside the tunnel plus 25m to the residence from the tunnel portal) based on standard point source distance loss only. Hence there is a further loss of 33 dB (70 less the predicted 37) due to other factors (eg tunnel lining, barrier, air absorption or other) that should be explained as this is a significant amount of energy loss. Again a diagrammatic or graphic showing relative locations of fans, portal and receiver should be provided to assist in demonstrating factors influencing these predictions.

26. A sound emission value is not provided for the ventilation and fresh air supply facilities, and instead a specification is provided for each needed to meet criteria. This is not an ideal assessment approach. Data from similar installations where such specifications are achieved should be provided. This may include at source emission values and insertion loss of required attenuators etc. to give confidence in the assessment. Also, as above, the controlling criteria may change due to RBL values from additional monitoring locations and therefore alter the specifications presented.

27. Section 9.8 Predicted modifying factors

Attenuators often change the frequency characteristics of the source they are attenuating. Hence, the INP low frequency or tonal penalties could apply to such sources. If such penalties are to apply, this puts further pressure on the design specification needed to meet criteria. Examples of tested plant should be provided to confirm, or otherwise, application of such penalties, and to provide confidence that criteria can be achieved.

28. Section 10.4 Noise management levels for construction activity

As noted in Item 1, the position of noise monitors used for the construction noise assessment is unlikely to be suitable for construction assessment given monitors were generally in the noisiest position within the NCAs. Therefore the assessment of construction noise may not have been completed in accordance with the ICNG. Justification should be provided for the use of the monitoring data for this purpose, or alternate data collected.

29. Section 10.5.1 Construction equipment

Table 31 provides 'Sound Power Level (dBA)' by 'item', 'activity' and ' L_{WAmax} activity'. Explanations or definitions of each of these terms should be provided. The addition of the items for some scenarios matches the 'activity', yet for other scenarios matches the ' L_{WAmax} activity' and therefore indicating a possible inconsistency in the approach requiring clarification.

30. Table 31 nominates open-ended durations as '> 6 months'. An upper estimate of such works should be provided, eg '>6months to 18 months' to better inform the community.

40. Section 10.6 Noise assessment at the nearest noise sensitive receivers

This section clearly demonstrates that significant noise level exceedances are expected due to the project and across many areas of works. The quoted worst case levels being '>90 dBA' and the like should be better defined and include specific predicted levels.

41. Section 10.7 Cumulative noise impacts

The statements made in this section with regard to why cumulative noise impacts have not been predicted for some activities is unclear. It is stated that "...plant and equipment will move about the worksites and will not all be operating concurrently...". This explanation would apply equally to predictions that have been provided for individual work sites in previous sections and hence requires additional clarification. Alternatively, predictions for overlapping activities across all work sites should be provided to quantify the potential noise impacts at receivers.

42. Section 10.8.3 Construction noise mitigation measures

Acoustic building enclosures at tunnelling sites is said to reduce noise by up to 22 dB. Maps in Appendix R for without and with mitigation do not reflect such reductions and in many cases these maps show noise contours to be largely unchanged. This should be explained further.

43. Section 11.2 Construction traffic noise assessment

Table 51 should include existing and proposed traffic volumes and noise levels. It should also state actual noise level changes that are shown presently as '>2 dB'.

44. Section 12.4 Excavation of main tunnels

The predictions presented should include discussion on whether multiple roadheaders will be used concurrently and if cumulative impacts from such activities are possible and if so, whether this has been included in the presented predictions.

45. Section 12.7 Ground-borne noise mitigation

Information on whether the presented exceedances align with receptors also identified as being highly affected from air borne construction noise (ie 75 dBA) should be provided, and therefore whether alternate accommodation should be a mitigation option for ground borne noise exceedances.

46. Section 13.8 Blasting

Potential blasting vibration levels should be provided for representative assessment locations (ie nearest to tunnel cross passages or where benching is likely).

7 Post exhibition review

7.1 Government agencies

7.1.1 Environment Protection Authority (EPA)

The EPA raised a number of noise and vibration issues in its submission. These were regarding bringing forward the noise and vibration management plan, justification for the selection of noise catchment areas (NCAs), justification of selected noise monitoring locations, noise mitigation, impacts of motorway ramps, queuing and idling construction vehicles, and reversing and movement alarms.

Additional noise monitoring data completed by the proponent was provided separately to EMM and we consider that this and the responses provided in the submissions report addresses the EPA's submission.

With respect to noise mitigation, the EPA correctly highlight the Road Noise Policy (RNP) recommendation of treatment to be provided to the two most noise affected floors. The proponent's response in this regard is not considered to adequately address this matter. However, this issue will be appropriately addressed by the recommended draft conditions of approval provided in Section 9 herein, if the DP&E grant the project approval.

Impacts of motorway ramps have been modelled and assessed as free-flowing traffic although the proposed design is that they will be signalised. The EPA request further information to support this approach. The proponent's response refers back to the cited material in the original EIS (ie a case study by Brown (1996)). This issue is important but does not change the criteria or the final mitigation that will be required as determined in the detailed design and verified with monitoring post completion. This issue will also be addressed through adoption of the recommended conditions of approval as provided in Section 9, should DP&E grant approval.

All other matters raised by the EPA are considered to have been adequately addressed by the proponent's responses.

7.1.2 NSW Health

NSW Health raise several noise and vibration issues. These include noise during construction, operation, background noise, predictions, management, communication and mitigation for vulnerable individuals.

The NSW Health submission is considered to be adequately addressed in the proponent's EIS and responses. This includes environmental management measures that require a noise monitoring program to assist in confirming and controlling noise during commencement of construction activities and periodically during the construction, as well as validation through monitoring traffic noise within 12 months of the new road opening. This, together with adoption of the recommended draft conditions in Section 9 herein, should DP&E grant approval, are considered to address the issues raised.

7.2 Local Councils

Ashfield Council's submission raises issues around assessment methodology, addressing the SEARs, background noise monitoring, ground-borne noise, variation in truck numbers at Northcote Street tunnel site, construction traffic, regenerated noise, vibration assessment, operational traffic noise modelling, architectural building treatment, assessment locations, construction of noise walls, night construction traffic, validation of the traffic noise model and depths of portals and ramps.

The Ashfield Council's submission is considered to be adequately covered in the proponent's EIS and the Submissions report, and additional monitoring completed post the RTS and PIR that EMM has reviewed. This, together with adoption of the recommended draft conditions in Section 9 herein, should DP&E grant approval, are considered to address the issues raised.

City of Canada Bay Council's submission raises issues around construction impacts at Lucas Garden Public School, noise barriers and treatment of dwellings.

The City of Canada Bay Council's submission is considered to be adequately covered in the proponent's EIS and the Submissions report. This, together with adoption of the recommended draft conditions in Section 9 herein, should DP&E grant approval, are considered to address the issues raised.

Strathfield Council's submission raises issues around multi-level residences acoustic treatment, western ventilation facility, noise management measures and impacts on proposed residential developments.

The Strathfield Council's submission is considered to be adequately covered in the proponent's EIS and the Submissions report. This together with the recommended draft conditions in Section 9 herein, should DP&E grant approval, are considered to address the issues raised.

7.3 Community and other key stakeholders

A total of 4,812 submissions were received from the community and a number of other key stakeholders also made submissions. However, noise and vibration was not a common issue raised in these submissions.

In addition, one petition containing 1,427 signatures as well as form letters (totalling 4,040 individual forms) were received.

Issues relating to noise and vibration (including blasting) from the community are addressed by the proponent throughout Chapter 5 and more specifically in Section 5.9 of the Response to Submissions report (Volume 1B). The submissions include:

- 223 related to airborne construction noise;
- 14 relating to ground-borne noise from construction (ie tunnelling);
- 76 relating to vibration from surface works;
- 25 relating to vibration from tunnelling during construction;
- two relating to blasting;
- 32 relating to traffic noise during construction;

- 35 relating to out of hours construction works;
- 476 relating to property damage during construction;
- 11 relating to cumulative noise impacts during construction;
- 14 relating to adequacy of the operational noise assessment;
- six relating to operational vibration;
- 428 relating to provision and location of barriers;
- 40 submissions relating to at-property acoustic treatment;
- four relating to operation of ancillary facilities; and
- three relating to cumulative noise impacts during operation.

The submissions are considered to be adequately covered in the proponent's EIS and the Submissions report, and additional monitoring completed post the Submissions Report that EMM has reviewed. This, together with adoption of the recommended draft conditions in Section 9 herein, should DP&E grant approval, are considered to address the issues raised.

8 Preferred project review

8.1 Changes

Since the EIS assessments there has been seven key changes nominated to the project. These are summarised as follows:

1. Expansion of the construction footprint at the Homebush Bay Drive civil site (C1) to the north;
2. Proposed changes to the configuration of the Homebush Bay Drive interchange;
3. Re-orientation of the Sydney Street substation;
4. A construction access tunnel at the Concord Road interchange;
5. Addition of an emergency smoke exhaust to the fresh air supply facility at Cintra Park;
6. Proposed changes to the configuration of the Wattle Street (City West Link) interchange; and
7. Proposed works to the intersection of Ramsay Street and Martin Street (west) at Haberfield to maintain acceptable access to properties.

Volume 2 of the M4 East Submissions Report provides a noise and vibration assessment of design changes at Appendix D. EMM has reviewed the changes as summarised below.

8.2 Homebush Bay Drive interchange

The revised alignment improves connection to the main carriageway for eastbound on ramp traffic from Homebush Bay Drive and removes the need for an elevated bridge structure adjacent Verley Drive. It also includes an increased elevation of the westbound off ramp to Homebush Bay Drive.

The proposed changes to the Homebush Bay drive interchange result in a marginal improvement in operational noise impacts for receivers in its vicinity (eg chainage 500 to 800) and on the north side of the M4 because the elevated bridge structure is being removed from the design. However, additional receivers on the southern side of the M4 are triggered for mitigation because the changes reduce the screening offered by the previous design.

Low noise pavement is now proposed for the surface sections of the M4 East carriageway and modified sections, providing a reduction in noise of 2 dB.

The revised design, including the recommended additional mitigation, results in negligible change in the total number of at property treatments for the project. One more receiver than in the EIS has been identified for at-property treatment.

A comparison of maximum (L_{Amax}) noise levels between the EIS and the modified design shows improvements for NCA01 North, NCA02 and NCA03. However, increases are expected in NCA01 South with the new flyover closer to these receivers. Some receivers in these catchments are eligible for consideration of at-property treatments as part of the project. Detailed design should consider maximum noise levels and include feasible and reasonable noise mitigation.

8.3 Wattle Street interchange

The revised alignment means the west bound entry is closer to receivers in NCA17 and NCA18, however the dive structure provides noise screening benefits. The west bound Wattle Street connection moves south and closer to receivers. However, the combined effect is a marginal reduction in noise levels compared to the EIS design. The changes in noise mitigation as a result of the revised design compared to the EIS are:

- overall a minor reduction in receivers eligible for consideration of additional noise mitigation (four less than in the EIS);
- improved barrier design for Wattle Street at Martin Street, which means this barrier is now more likely to be constructed;
- an increase in the height of a specific section of Wattle Street noise barrier (known as NW_Wattle_01G) of 0.5 m (final height to be 5.5 m subject to the detailed design);
- a relatively minor reduction (four less than in the EIS) in the number of receivers eligible for consideration of at-property treatment; and
- lower maximum noise levels at NCA17 and NCA18 due to changes in barrier design in these areas.

8.4 Construction noise - Homebush Bay civil site expansion

The noise emissions for construction works within the expanded area of the site are predicted to satisfy noise criteria at the majority of receivers for the majority of the time. The exception being a marginal 2 dB exceedance of the daytime NML at NCA01 residences during installation of temporary fencing. The proposed hours of construction for this site are the recommended standard hours only.

Noise impacts associated with the revised construction site are considered minor.

It is noted that the additional noise logging conducted in October 2015 should be adopted where relevant to this assessment. This can be done through the CNVMP and the detailed design process.

8.5 Other modifications

The above three elements are the only ones re-assessed in detail for noise and vibration of the seven changes. Some commentary on the remaining four changes is provided, however, the changes are not considered material and in some cases the EIS assessment remains mostly valid or they can be addressed through conditions of consent if the department were to grant approval. For example, reorientation of the Sydney Street substation would likely result in comparable or less impact given the increased distance to receivers to the position of the reorientated emission point(s) of this noise source. Furthermore, the submissions report states "The substation would operate within an enclosure that would minimise potential impacts – particularly noise. If necessary, noise could be further limited with the introduction of engineering controls such as barriers, silencers and acoustic lining." The noise impacts of the plant forming part of this substation would be subject to detailed design and would need to comply with the requirements of the Industrial Noise Policy.

The construction access tunnel at the Concord Road interchange is underground and therefore does not pose a noise issue at the surface. Vibration impacts would be controlled via the Revised Environmental mitigation measures outlined in Chapter 8 of the Submissions Report.

The addition of an emergency smoke exhaust to the fresh air supply facility at Cintra Park is not likely to impact the community given the use (emergency only). It will be contained wholly within the proposed supply air facility as presented and assessed in the EIS and no additional plant is proposed.

Lastly, details are not yet available for proposed works to the intersection of Ramsay Street and Martin Street (west) at Haberfield and hence will need to be addressed during detailed design. During operations, negligible changes in traffic volumes are anticipated for Martin Street and at the Ramsay Street and Wattle Street intersection as compared to existing overall traffic volumes. Hence, associated traffic noise level impacts are unlikely.

9 Draft recommended conditions

The following section provides recommended actions and conditions of approval that could be applied to avoid, minimise, mitigate and/or manage the residual noise and vibration impacts (should the Department recommend approval of the project). These are based on approvals for similar projects in NSW and include both generic as well as project specific conditions.

9.1 Land use survey

1. Prior to the commencement of construction, a detailed land use survey shall be completed to confirm sensitive receivers with respect to construction vibration, construction ground-borne noise and operational noise impacts (for example, educational facilities, laboratories with sensitive equipment and heritage structures). Additional noise monitoring should be carried out to confirm rating background levels and existing traffic noise levels for the areas of NCAs that are removed from major roads. The results of the detailed land use survey and additional noise monitoring shall be detailed in the Construction Noise and Vibration Management Plan required by these conditions.

The detailed land use survey may be undertaken on a progressive basis in discrete areas, provided that the land use survey and additional noise monitoring is completed and detailed in the Construction Noise and Vibration Management Plan, approved by the Secretary, prior to the commencement of the works that would impact on sensitive receivers.

9.2 Construction hours

2. Construction activities shall be undertaken during the following standard construction hours:
 - a) 7:00am to 6:00pm Mondays to Fridays, inclusive;
 - b) 8:00am to 1:00pm Saturdays; and
 - c) at no time on Sundays or public holidays.
3. Notwithstanding condition 2, tunnelling may be undertaken 24 hours, seven days per week. Other activities associated with the project (such as work area establishment, temporary road and intersection modifications, roads/cut-and-cover/dive structures and approach roads and ramps, tunnelling site operations, including excavation and ground support, civil, mechanical, and electrical, and ventilation facilities construction) may be undertaken outside the hours specified in condition 2 where allowed in accordance with condition 5.
4. Except as permitted by an EPL, activities resulting in impulsive or tonal noise emissions shall only be undertaken:
 - a) between the hours of 8:00 am to 6:00 pm Monday to Friday;
 - b) between the hours of 8:00 am to 1:00 pm Saturday; and
 - c) in continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block.

For the purposes of this condition, 'continuous' includes any period during which there is less than a one hour respite between ceasing and recommencing any of the work that is the subject of this condition.

5. Notwithstanding the above conditions, construction works (including work area establishment, temporary road and intersection modifications, roads/cut-and-cover/dive structures and approach roads and ramps, tunnelling site operations, including excavation and ground support, civil, mechanical, and electrical, and ventilation facilities construction) associated with the project may be undertaken outside the hours specified in the following circumstances:
 - a) construction works that cause $L_{Aeq,15 \text{ minute}}$ noise levels that are:
 - i) No more than 5 dB above rating background level at any residence in accordance with the Interim Construction Noise Guideline (DECC, 2009); and
 - ii) No more than the noise management levels specified in Table 3 of the Interim Construction Noise Guideline (DECC, 2009) at other sensitive landuses; or
 - b) where a negotiated agreement has been arranged with affected receivers;
 - c) for the delivery of materials required by the police or other authorities for safety reasons;
 - d) where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm; and
 - e) construction works approved through an Environment Protection Licence (including an approved Out-Of-Hours Work Protocol prepared as part of the Construction Noise and Vibration Management Plan). The protocol must include notification of the relevant Council, local residents and other affected stakeholders and sensitive receivers of the timing and duration at least 48 hours prior to the commencement of the works.

9.3 Construction noise and vibration

6. The Proponent shall implement all reasonable and feasible noise mitigation measures with the aim of achieving the following construction noise management levels and vibration criteria:
 - a) construction noise management levels established using the Interim Construction Noise Guideline (DECC 2009);
 - b) vibration criteria established using the Assessing Vibration: a Technical Guide (DECC 2006) (for human exposure); and
 - c) the vibration limits set out in the German Standard DIN 4150-3: Structural Vibration effects of vibration on structures (for structural damage).

Any construction activities identified as exceeding the construction noise management levels and/or vibration criteria shall be managed in accordance with the approved Construction Noise and Vibration Management Plan required by these conditions.

Note: The Interim Construction Noise Guideline identifies 'particularly annoying' activities that require the addition of 5 dB to the predicted level before comparing to the construction NML.

7. Reasonable and feasible noise mitigation measures should be applied to construction activities when the following residential ground-borne noise levels are exceeded:
 - a) Evening (6:00pm to 10 pm) — Internal $L_{Aeq,15 \text{ minute}}$: 40 dB; and
 - b) Night (10pm to 7am) — Internal $L_{Aeq,15 \text{ minute}}$: 35 dB.

The mitigation measures should be outlined in the Construction Noise and Vibration Management Plan (including the Out-Of-Hours Work Protocol) required by this approval.

8. Wherever practical, piling activities that affect sensitive receivers shall be undertaken using quieter alternative methods than impact or percussion piling, such as bored piles or vibrated piles.
9. The Proponent shall implement operational noise mitigation measures at receivers, or equivalent temporary measures, at the start of construction, and in areas where the EIS, Submissions report have identified high noise impacts (including at or adjacent to construction work sites or ancillary facilities), and where existing noise barriers are to be altered.
10. The Proponent shall conduct vibration testing and monitoring to identify minimum working distances to retained heritage items to prevent cosmetic damage to these items. In the event that the vibration testing and monitoring shows that the preferred values for vibration are likely to be exceeded, the Proponent shall review the construction methodology and, if necessary, implement additional reasonable and feasible mitigation measures, unless otherwise agreed to by the Director-General.
11. The Proponent shall consult with potentially-affected community, religious, educational institutions and vibration-sensitive businesses and critical working areas (such as theatres, laboratories and operating theatres) to ensure that noise generating construction works in the vicinity of the receivers are not timetabled during sensitive periods, unless appropriate other arrangements are made.
12. During construction, Proponents of other construction works in the vicinity of WestConnex M4 East shall be consulted and reasonable steps taken to coordinate works to minimise impacts on, and maximise respite for, affected sensitive receivers.
13. The Proponent shall prepare a Construction Noise and Vibration Management Plan to detail how construction noise and vibration impacts will be minimised and managed. The Plan shall be consistent with the guidelines contained in the Interim Construction Noise Guidelines (Department of Environment and Climate Change 2009). The plan shall be developed in consultation with the EPA and shall include, but not be limited to:
 - a) identification of the work areas, site compounds and access points;
 - b) identification of sensitive receivers and relevant construction noise and vibration goals applicable to the project and stipulated in the conditions above;
 - c) details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities (based on representative construction scenarios, including at ancillary facilities) that have the potential to generate noise and/or vibration impacts on surrounding sensitive receivers, particularly residential areas;

- d) an Out-of-Hours Work Protocol for the assessment, management and approval of works outside of standard construction hours as defined in this approval, for the Secretary's approval. The Out-of-Hours Work Protocol must detail:
 - i) assessment of out-of-hours works against the relevant noise and vibration criteria;
 - ii) detailed mitigation measures for any residual impacts (that is, additional to general mitigation measures), including extent of at-receiver treatments;
 - iii) where the out-of-hours works include spoil haulage, commitment to at receiver treatment at properties that would experience residual impacts, and, unless approved by the Secretary, avoidance of out-of-hours access to local roads; and
 - iv) proposed notification arrangements.
- e) identification of feasible and reasonable measures proposed to be implemented to minimise and manage construction noise impacts (including construction traffic noise impacts), including, but not limited to, acoustic enclosures, erection of noise walls (hoardings), respite periods and the limiting of truck movements during night periods;
- f) identification of feasible and reasonable procedures and mitigation measures to ensure relevant vibration and blasting criteria are achieved, including suitable blast program, applicable buffer distances for vibration intensive works, use of low vibration generating equipment/ vibration dampeners or alternative construction methodology, and pre- and post- construction dilapidation surveys of sensitive structures where blasting and/ or vibration is likely to result in damage to buildings and structures (including surveys being undertaken immediately following a monitored exceedance of the criteria);
- g) details of tunnelling, including associated impacts, management and mitigation measures;
- h) if blasting is required, an assessment of the potential noise and vibration impacts, and a strategy to minimise and manage those impacts, including preparation of an appropriate community information program;
- i) a description of how the effectiveness of mitigation and management measures would be monitored during the proposed works, clearly indicating how often this monitoring would be conducted, the locations where monitoring would take place, how the results of this monitoring would be recorded and reported, and, if any exceedance is detected, how any noncompliance would be rectified; and
- j) mechanisms for the monitoring, review and amendment of this plan.

9.4 Construction traffic noise

14. Construction traffic movements on public roads shall aim to limit any increase in existing road traffic noise levels to no more than 2 dB. All feasible and reasonable noise mitigation and management measures shall be implemented and any activities that could exceed the construction noise management levels shall be identified and managed in accordance with the Construction Noise and Vibration Management Plan.

15. The Proponent is to ensure that construction vehicle contractors operate so as to minimise impacts. Measures that could be used include toolbox talks, contracts that include provisions to deal with unsatisfactory noise performance for the vehicle and/or the operator, and specifying non-tonal movement alarms in place of reversing beepers or alternatives such as reversing cameras and proximity alarms, or a combination of these, where tonal alarms are not mandated by legislation.
16. No use of compression brakes shall be permitted for construction vehicles associated with the project during construction.

9.5 Blasting

17. Should blasting be required, the Proponent shall prepare a Blast Management Strategy in consultation with the EPA and incorporate this Strategy into the Construction Noise and Vibration Management Plan required under this approval. The Strategy shall be prepared with an aim to demonstrate that all blasting and associated activities will be undertaken in a manner that will not generate unacceptable noise and vibration impacts or pose a significant risk of impact to residences and sensitive receptors. The Strategy shall also address the principles outlined in Hazardous Industry Planning Advisory Paper No 6: Hazard Analysis (Department of Planning January 2011) and Assessment Guideline: Multi-Level Risk Assessment (Department of Planning and Infrastructure May 2011) for the handling and storage of hazardous materials. Issues to be considered in the Strategy shall include, but not necessarily be limited to:
 - a) details of blasting to be performed, including location, method and justification of the need to blast;
 - b) identification of any potentially affected noise and vibration sensitive sites including heritage buildings and utilities;
 - c) establishment of appropriate criteria for blast overpressure and ground vibration levels at each category of noise sensitive site;
 - d) details of the storage and handling arrangements for explosive materials and the proposed transport of those materials to the construction site;
 - e) identification of hazardous situations that may arise from the storage and handling of explosives, the blasting process and recovery of the blast site after detonation of the explosives;
 - f) determination of potential noise and vibration and risk impacts from blasting and appropriate best management practices; and
 - g) community consultation procedures.
18. The vibration levels for blasting activities, including both above ground and underground work, shall meet the requirements of conditions 23 and 24.
19. Blasts shall be limited to an average of one single detonation in any one day, and a maximum of six per week, unless otherwise agreed by the EPA through consultation on the Construction Noise and Vibration Management Plan.

20. For any section of tunnel construction where blasting is proposed, a series of initial trials at reduced scale shall be conducted prior to production blasting to determine site-specific blast response characteristics and to define allowable blast sizes to meet the airblast overpressure and ground vibration limits in conditions 23 and 24.
21. Blasting associated with the project shall only be undertaken during the following hours:
 - a) 9:00 am to 5:00 pm, Monday to Friday, inclusive;
 - b) 9:00 am to 1:00 pm Saturday; and
 - c) at no time on Sunday or on a public holiday.

This condition does not apply in the event of a direction from police or other relevant authority for safety or emergency reasons to avoid loss of life, property loss and/or to prevent environmental harm.

22. Where vibration levels exceed the acceptable vibration values, feasible and reasonable mitigation measures shall be considered and implemented.
23. Airblast overpressure generated by blasting associated with the project shall not exceed the criteria specified in Table 9.1 when measured at the most affected residence or other sensitive receiver.

Table 9.1 Airblast overpressure criteria

Airblast overpressure, dB(Lin Peak)	Allowable exceedance
115	5% of total number of blasts over a 12 month period
120	0%

24. Ground vibration generated by blasting associated with the project shall be limited for human comfort to the criteria specified in Table 9.2 when measured at the most affected residence or other sensitive receiver.

Table 9.2 Ground vibration criteria for human comfort (AS 2187.2)

Receiver	Peak component particle velocity (mm/s) ²
Sensitive site ¹	5 mm/s for 95% of all blasts measurable at one receiver (assuming at least 20 blasts are measurable) 10 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply
Occupied non-sensitive sites, such as industrial and commercial premises	25 mm/s maximum unless agreement is reached with occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specifications or levels that can be shown to adversely affect the equipment operation.

Notes:

1. A sensitive site includes houses, low rise residential buildings, child care centres, retirement homes, theatres, schools, hospitals, places of worship, and other similar buildings occupied by people.
2. The recommendations in Table J4.5(A) of AS 2187.2 are intended to be informative and do not override statutory requirements with respect to human comfort limits set by various authorities. They should be read in conjunction with any such statutory requirements and with regard to their respective jurisdictions.

25. The blasting criteria identified in conditions 23 and 24 do not apply where the Proponent has a written agreement with the relevant landowner to exceed the criteria and the Secretary has approved the terms of the written agreement. In obtaining the Secretary's approval for any such agreement, the Proponent shall submit to the Secretary:
- a) details of the proposed blasting program and justification for the proposed increase to blasting criteria including alternatives considered (where relevant);
 - b) an assessment of the environmental impacts of the increased blast limits on the surrounding environment and most affected residences or other sensitive receivers including, but not limited to noise and vibration and any risk to surrounding utilities, services or other structures;
 - c) details of the blast management, mitigation and monitoring procedures to be implemented; and
 - d) details of consultation undertaken and agreement reached with the relevant landowners (including a copy of the agreement in relation to increased blasting limits).

The following exclusions apply to the application of this condition:

- i) any agreements reached may be terminated by the landowner at any time should concerns about the increased blasting limits be unresolved;
- ii) the blasting limit agreed to under any agreement can at no time exceed a maximum Peak Particle Velocity vibration level of 25 mm/s or maximum Airblast Overpressure level of 125 dBL(Peak); and
- iii) the provisions under this condition (to increase applicable blast criteria in agreement with the relevant landowners) do not apply where the property is a heritage property.

9.6 Operational noise and vibration

26. The Proponent shall design and operate all fixed facilities, including the tunnel portals; western ventilation facility (Underwood Road Homebush), eastern ventilation facility (Parramatta Road and Wattle Street Haberfield), and fresh air intake (Cintra Park Concord); the Motorway Operations Complex; emergency smoke extraction outlets and the electrical substation, with the objective of not exceeding the requirements of the NSW Industrial Noise Policy (EPA 2000) and the Sleep Disturbance Application Note to the Industrial Noise Policy (DEC 2007). The Proponent shall apply mitigation at existing receivers where the noise requirements cannot be achieved.
27. A detailed Operational Noise Management Plan shall be prepared as part of the OEMP, to the satisfaction of the Secretary. The Plan shall provide details of noise and vibration control measures to be undertaken during the operation stages, sufficient to address the technical requirements of the EPA, and generally in accordance with the Road Noise Policy (DECCW 2011) and the Industrial Noise Policy (EPA 2000).

The Plan shall include, but not be limited to:

- a) tests for ascertaining acoustic parameters;
 - b) predicted noise levels;
 - c) noise criteria for operation of the project;
 - d) location, type and timing of erection of permanent noise barriers and/or other noise mitigation measures demonstrating best practice including silencers and building treatments for associated plant rooms and enclosures for exposed plant;
 - e) specific physical and managerial measures for controlling noise; and,
 - f) noise monitoring, reporting and response procedures including the monitoring on surrounding roads which experience significantly increased traffic volumes as a result of the project.
28. For the purpose of assessment of noise criteria specified in the Operational Noise Management Plan, noise from the development shall be:
- a) measured at the most affected point on or within the site boundary at the most sensitive locations to determine compliance with $L_{Aeq,T}$ noise limits;
 - b) measured in the free field at least three to five metres from any vertical reflecting surface in line with the worst-affected dwelling facade to determine compliance with L_{Amax} noise limits; and
 - c) subject to the modification factors provided in Section 4 of the NSW Industrial Noise Policy (EPA 2000), where applicable.
- Notwithstanding, should direct measurement of noise from the fixed facilities be impractical, the Proponent may employ an alternative noise assessment method deemed acceptable by the EPA (refer to Section 11 of the NSW Industrial Noise Policy (EPA 2000)). Details of such an alternative noise assessment method accepted by the EPA shall be submitted to the Secretary prior to the implementation of the assessment method.
29. Monitoring of operational noise shall be undertaken in accordance with the Operational Noise Management Plan. The Proponent shall, in consultation with the EPA, assess the adequacy of the traffic noise and ventilation noise mitigation measures within one year of operation, with regard to the criteria specified in the Operational Noise Management Plan. Should assessment indicate a clear trend in traffic noise levels on surrounding roads which exceed Operational Noise Management Plan defined noise criteria as approved by the EPA, the Proponent shall implement further reasonable and feasible mitigation measures in consultation with affected landowners and/or occupiers.
30. The Proponent shall design and operate WestConnex M4 East with the objective, where reasonable and feasible, of not exceeding the vibration goals for human exposure for existing receivers, as presented in Assessing Vibration: A Technical Guideline (DECC, 2006).

31. The Proponent shall prepare an Operational Noise and Vibration Review (ONVR) to confirm noise and vibration control measures that would be implemented for the project. The Operational Noise and Vibration Review shall be prepared in consultation with the Department, the EPA, relevant Councils, other relevant stakeholders and the community and shall:
- a) identify the appropriate operational noise and vibration objectives and levels for adjoining development, including existing sensitive receivers;
 - b) confirm the operational noise predictions of the project based on the final design. This operational noise assessment shall be based on an appropriately calibrated noise model (which has incorporated additional noise monitoring and concurrent traffic counting, where necessary for calibration purposes). The assessment shall specifically include verification of noise levels at all fixed facilities, based on additional noise monitoring undertaken at appropriately identified noise catchment areas surrounding these facilities;
 - c) predict the operational noise and vibration impacts at adjoining development based on the final design of the project, including operational daytime $L_{Aeq,15hr}$ and night-time $L_{Aeq,9hr}$ traffic noise contours;
 - d) examine all reasonable and feasible noise and vibration mitigation measures, identify specific physical and other mitigation measures for controlling noise and vibration at the source and at the receiver (if relevant) including location, type and timing for the erection of permanent noise barriers and/or other noise mitigation measures;
 - e) include a consultation strategy to seek feedback from directly affected property owners (including educational institutions) on the noise and vibration mitigation measures; and
 - f) procedures for operational noise and vibration complaints management, including investigation and monitoring (subject to complainant agreement).

The ONVR is to be independently verified by a noise and vibration expert. The scope of the verification exercise undertaken by the noise and vibration expert is to be developed by the Proponent in consultation with EPA. The verification will be undertaken at the Proponent's expense and the independent expert shall be approved by the Director-General. The ONVR and independent review is to be submitted to the Director-General for approval prior to the commencement of construction of physical noise mitigation structures, unless otherwise agreed to by the Director-General.

The Proponent shall implement the identified noise and vibration control measures and make the ONVR publicly available.

32. The Proponent shall undertake a noise and vibration compliance assessment to confirm the predictions of the noise assessment referred to in the Operational Noise and Vibration Review. The noise and vibration compliance assessment shall be developed in consultation with EPA and undertaken within twelve months of the commencement of operation of WestConnex M4 East, or as otherwise agreed by the Director-General. The assessment shall include, but not necessarily be limited to:
- a) noise and vibration monitoring and compliance assessment, to assess compliance with draft condition 26, 27, 28 and the ONVR;
 - b) methodology for the assessment;

- c) details of any complaints received relating to operational noise and vibration impacts;
 - d) any required recalibration of the noise and vibration model taking into account considerations such as land use change (if applicable);
 - e) an assessment of the performance and effectiveness of the applied noise and vibration mitigation measures; and
 - f) identification, if required, of further noise and vibration mitigation measures to meet the draft conditions 26, 27, 28 and the objectives of the ONVR.
33. A Noise and Vibration Compliance Assessment Report providing the results of the assessment shall be submitted to the Director General and the EPA within 60 days of its completion. If the assessment indicates an exceedance of any of the draft conditions 26, 27, 28 and/or the objectives of the ONVR, the Proponent shall implement further feasible and reasonable measures (where required) to mitigate these exceedances in consultation with affected property owners.

Appendix A

Glossary of acoustic terms

A number of technical acoustic descriptions are used in this report. A list of terms and a brief explanation are provided in Table A.1.

Table A.1 **Glossary of acoustic terms**

Abbreviation or term	Description
ABL	The assessment background level (ABL) is defined in the INP as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L90 statistical noise levels.
Amenity criteria	The amenity criteria relate to all industrial noise. Where industrial noise approaches base amenity criteria, then noise levels from new industries need to demonstrate that they will not be an additional contributor to existing industrial noise.
ANZECC	Australian and New Zealand Environment Conservation Council
CNMP	Construction noise management plan
Day period ¹	Monday to Saturday: 7.00 am to 6.00 pm, on Sundays and public holidays: 8.00 am to 6.00 pm.
dB(A)	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
DGRs	Director-General's environmental assessment requirements
DP&E	Department of Planning and Environment (NSW government)
EPA	NSW Environment Protection Authority
EP&A Act	Environmental and Planning Assessment Act 1979 (NSW)
Evening period ¹	Monday to Saturday: 6.00 pm to 10.00 pm, on Sundays and public holidays: 6.00 pm to 10.00 pm.
ICNG	Interim Construction Noise Guideline
INP	Industrial Noise Policy (NSW EPA 2000)
Intrusive criteria	The intrusive criteria refers to noise that intrudes above the background level by more than 5 dB. The intrusiveness criterion is described in detail in this report.
L ₁	The noise level exceeded for 1% of the time.
L ₁₀	The noise level which is exceeded 10% of the time. It is roughly equivalent to the average of maximum noise level.
L ₉₀	The noise level that is exceeded 90% of the time. Commonly referred to as the background noise level.
L _{eq}	The energy average noise from a source. This is the equivalent continuous sound pressure level over a given period. The L _{eq(15min)} descriptor refers to an L _{eq} noise level measured over a 15-minute period.
Linear peak	The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.
L _{max}	The maximum sound pressure level received during a measuring interval.
Night period ¹	Monday to Saturday: 10.00 pm to 7.00 am, on Sundays and public holidays: 10.00 pm to 8.00 am.
NMP	Noise management plan
PSNL	The project-specific noise level (PSNL) are criteria for a particular industrial noise source or industry. The PSNL is the lower of either the intrusive criteria or amenity criteria.
RBL	The rating background level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the average background levels.
RNP	Road Noise Policy
RING	Rail Infrastructure Noise Guideline
Sound power level (L _w)	A measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.

Table A.1 **Glossary of acoustic terms**

Abbreviation or term	Description
Temperature inversion	A meteorological condition where the atmospheric temperature increases with altitude.
Vibration	A motion that can be measured in terms of its displacement, velocity or acceleration. The common unit for velocity is millimetres per second (mm/s).

Note: 1. excludes road traffic noise where Day: 07.00 am to 10.00 pm; Night: 10.00 pm to 07.00 am.

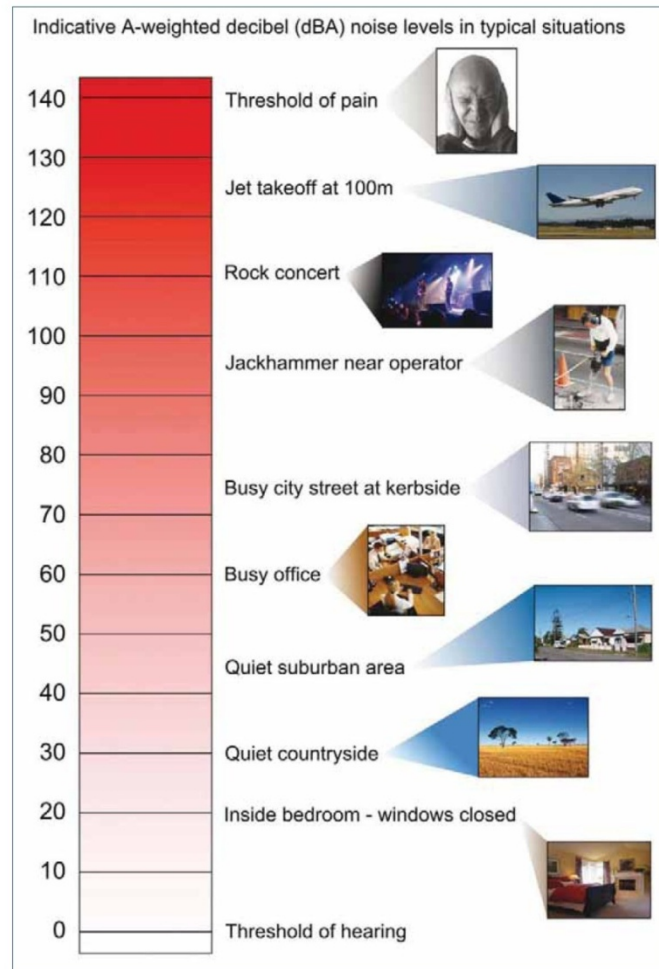
A.1 Common noise levels

It is useful to have an appreciation of dB, the unit of sound measurement when reading this assessment. Table A.2 gives some practical indication of what an average person perceives about changes in noise levels.

Table A.2 **Perceived change in noise**

Change in sound level (dB)	Perceived change in noise
3	just perceptible
5	noticeable difference
10	twice (or half) as loud
15	large change
20	four times as loud (or quarter) as loud

Examples of common noise levels are provided in Figure A.1.



Source: RTA Environmental Noise Management Manual (RTA 2001)

Figure A.1 Common noise levels

Appendix B

EIS Noise and vibration report graphics

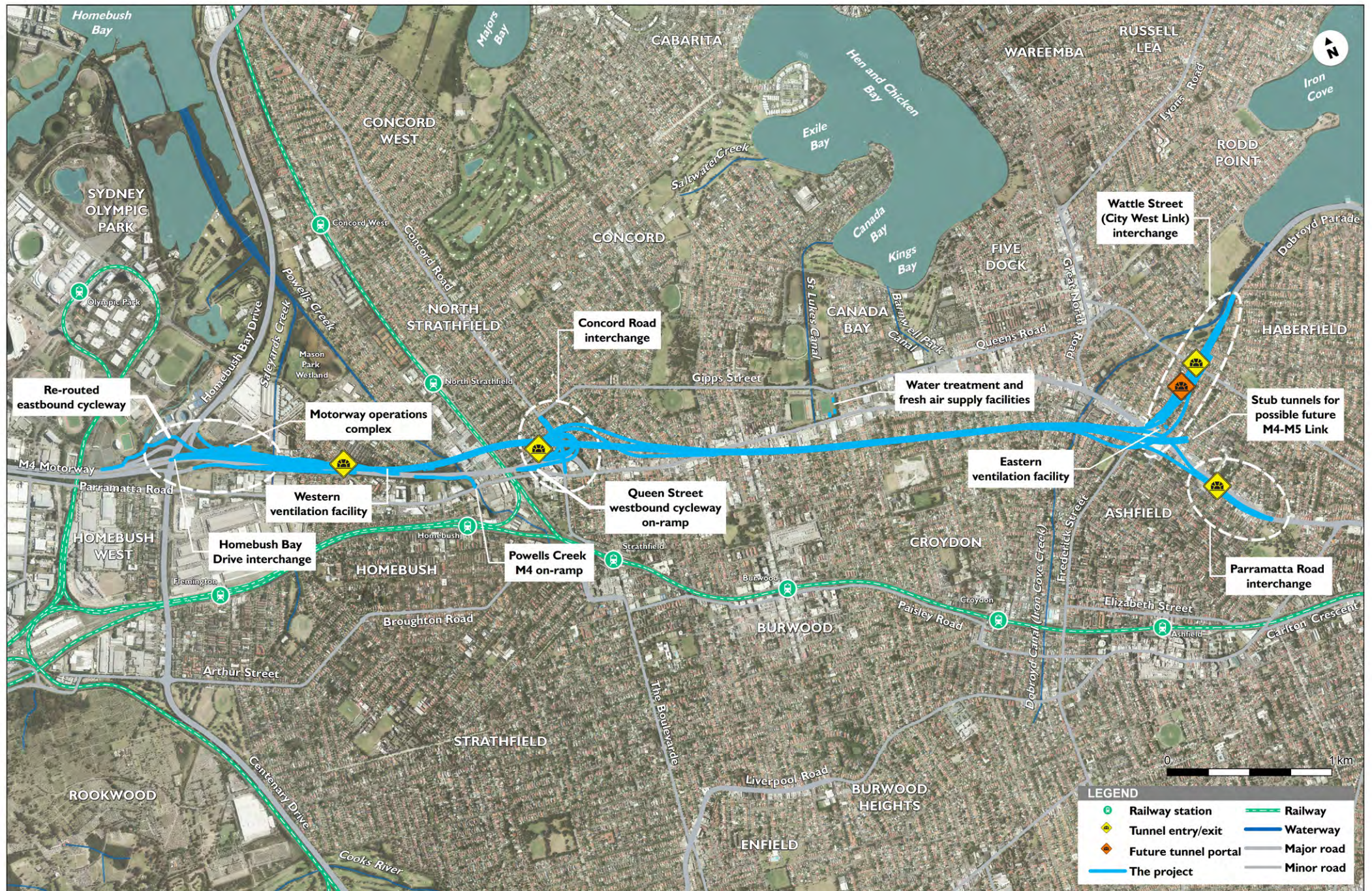


Figure 3 Overview of the project

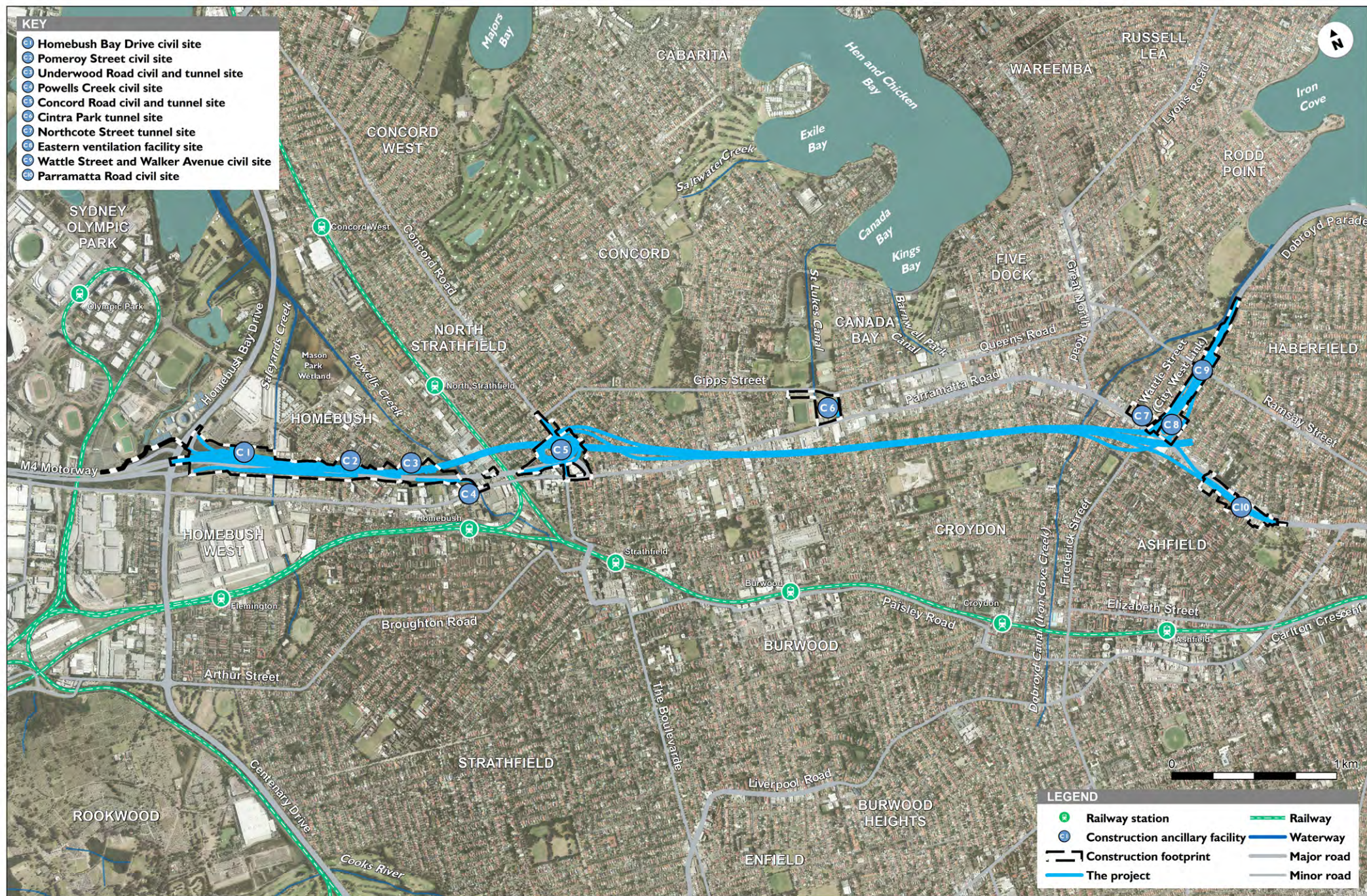
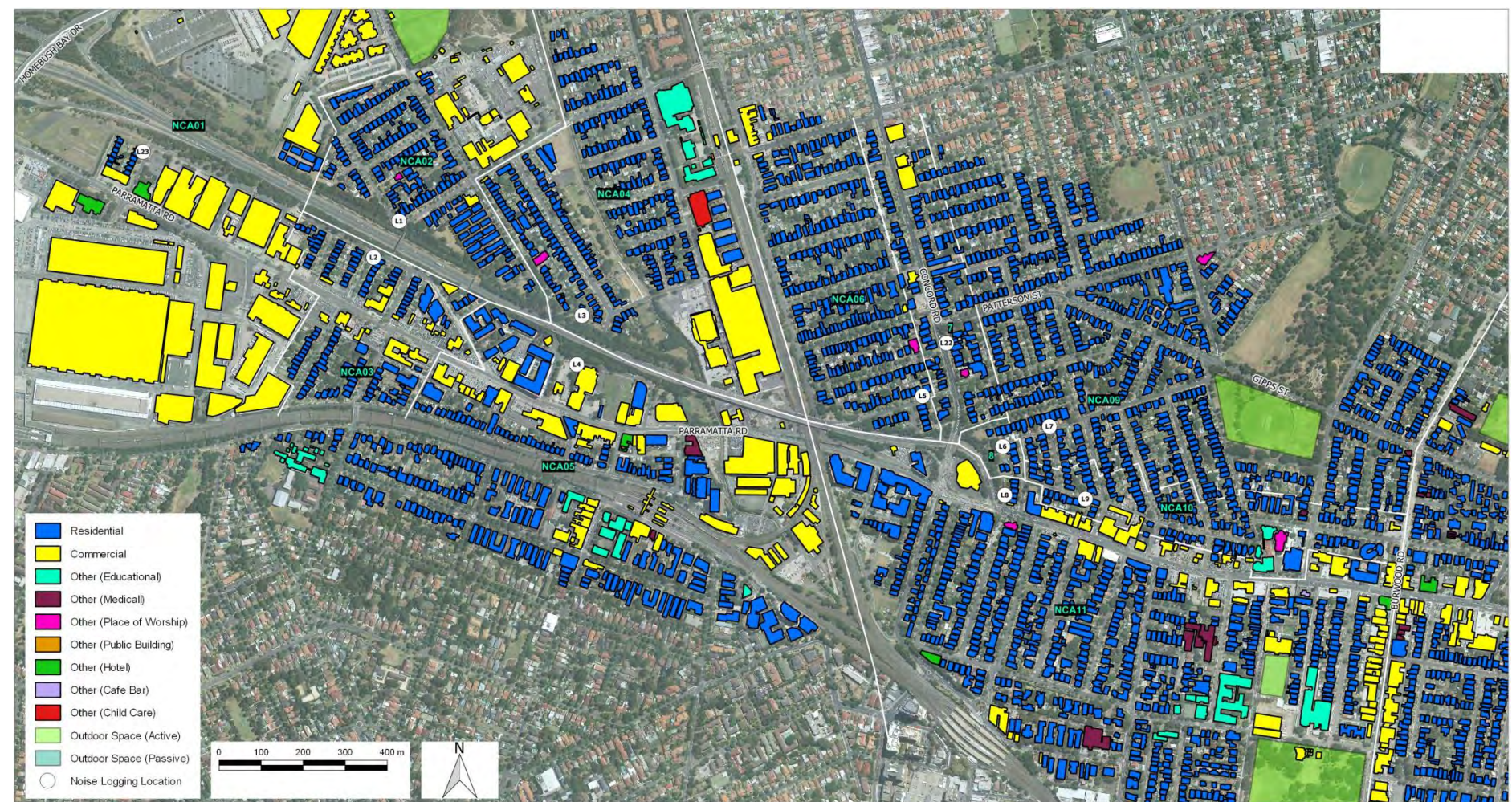


Figure 4 Overview of construction footprint and construction ancillary facilities

Figure 5 Site Plan and Sensitive Receivers Overview



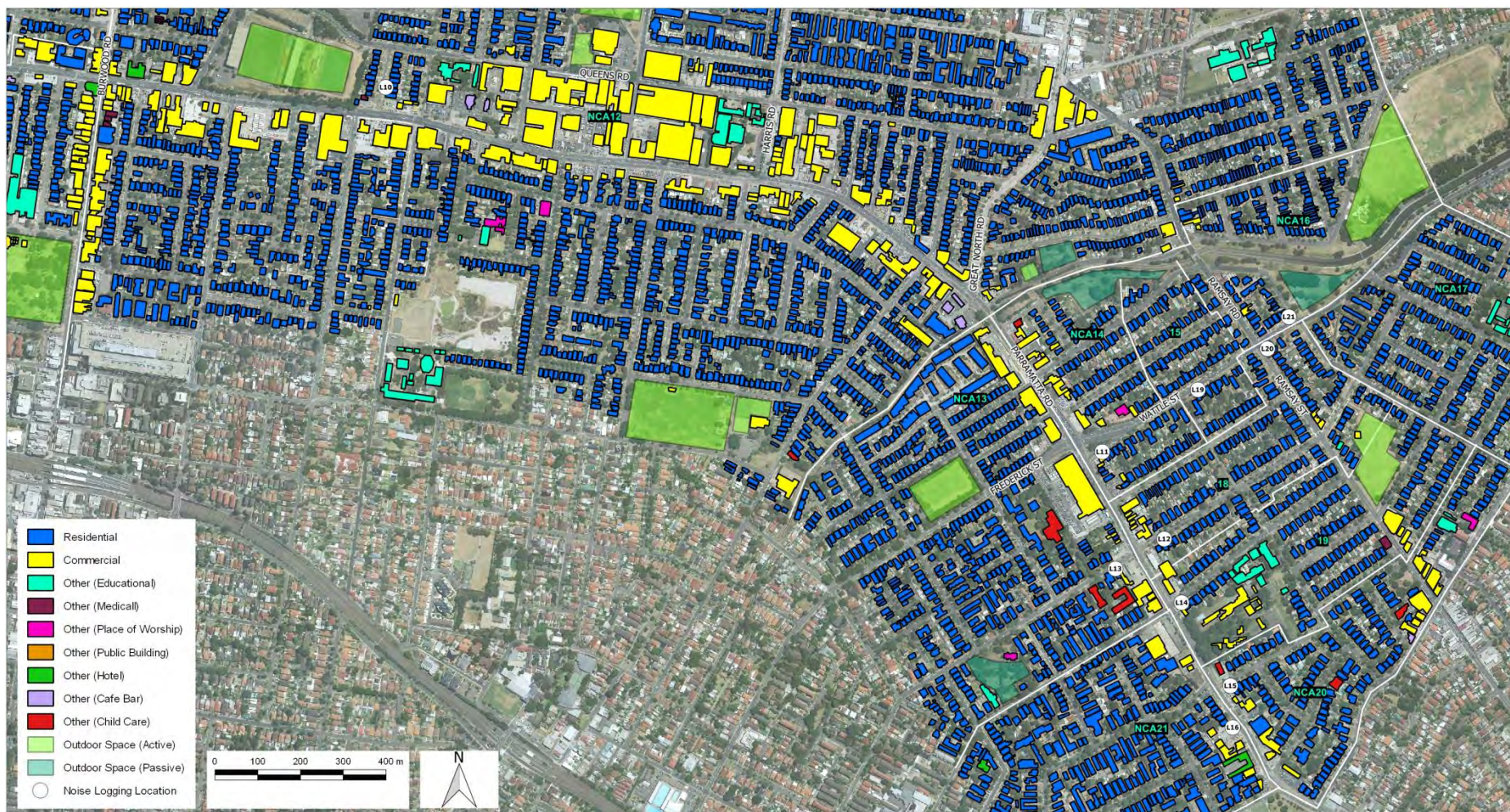
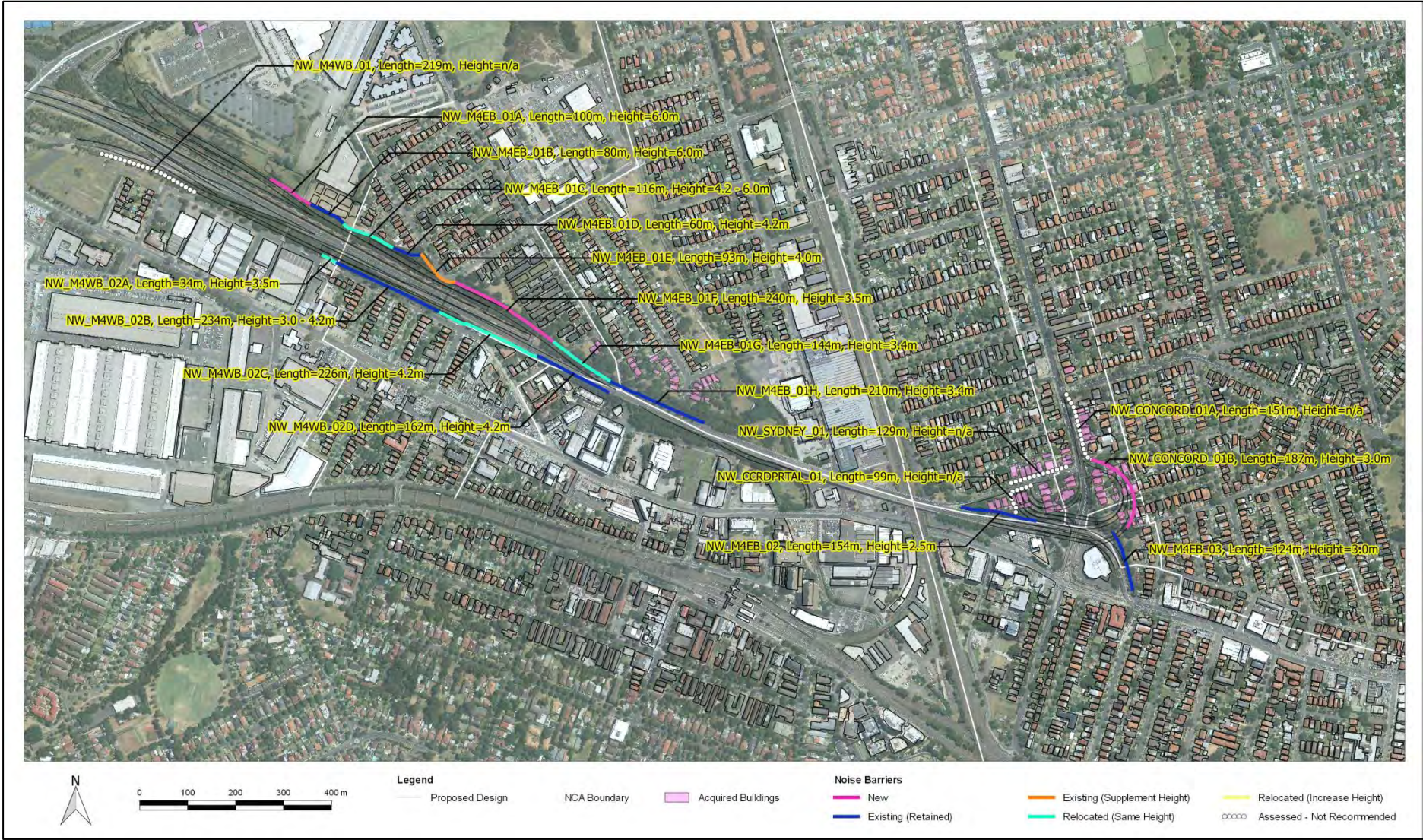


Figure 10 Noise barriers in the study area



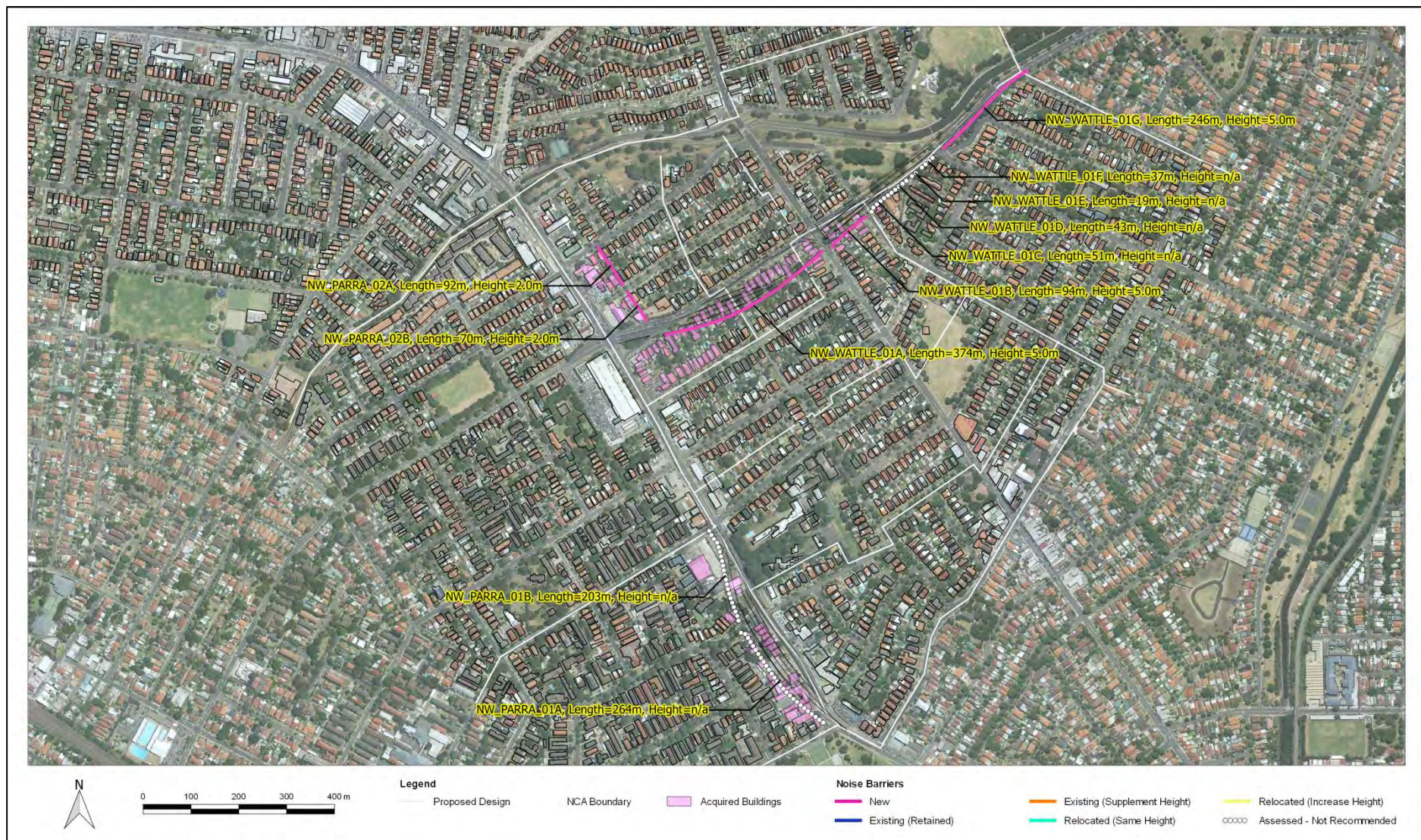
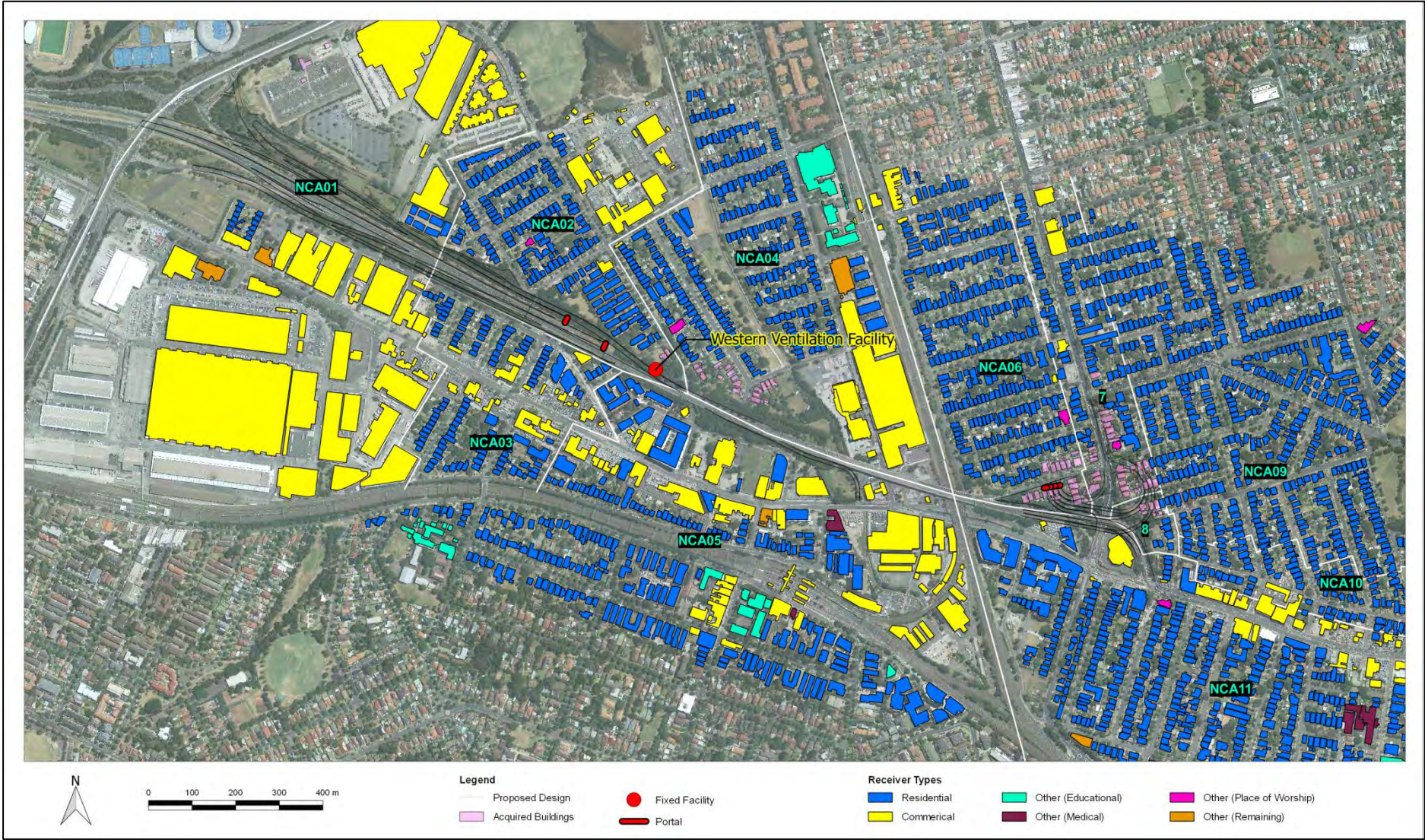
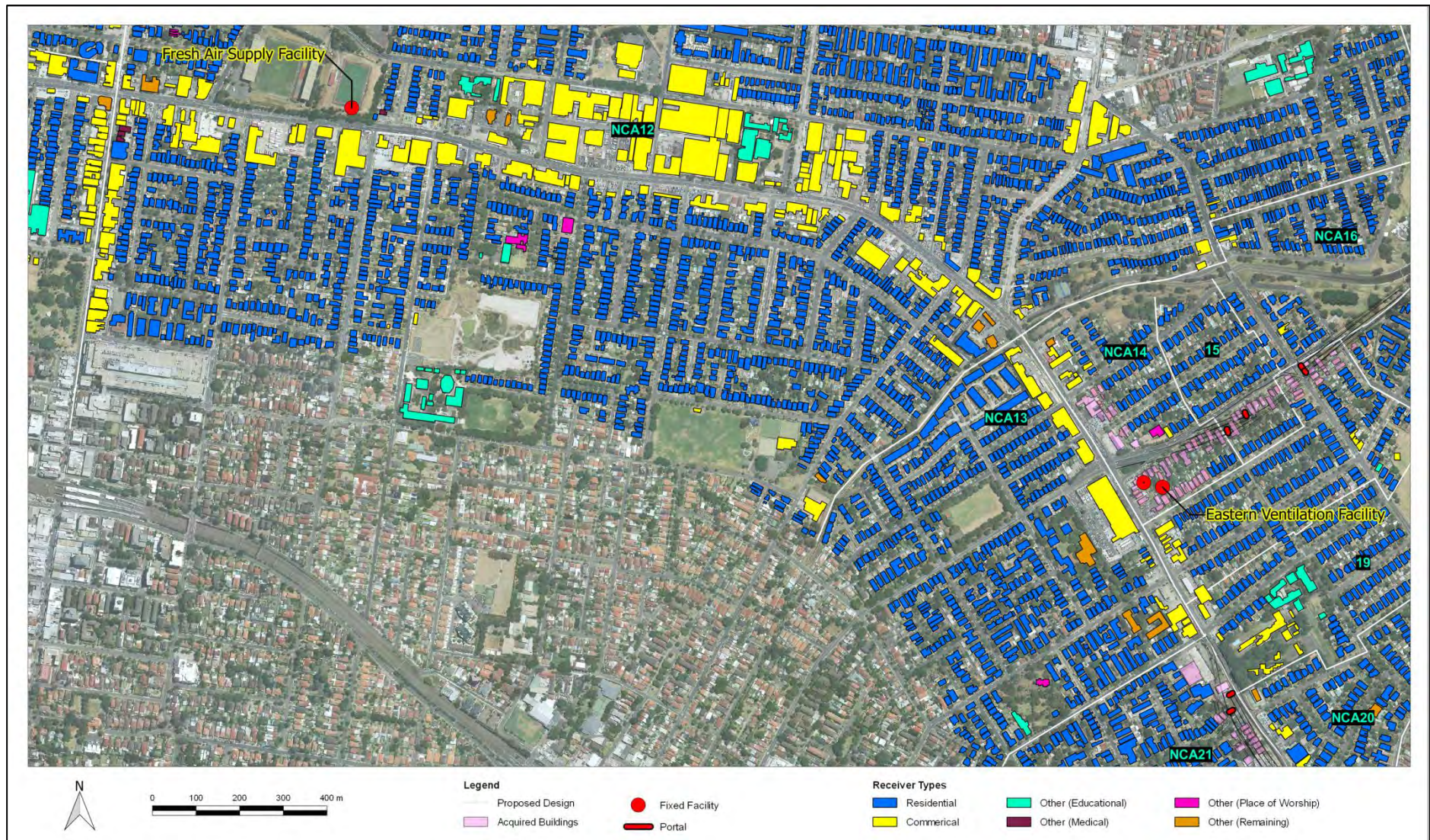


Figure 12 Location of ventilation facilities





Appendix C

Response to gap analysis

Table C.1 Preliminary Review Comments – Noise and Vibration

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
1	Section 3 – Description of the existing environment		
1.1	The adopted noise catchment areas (NCAs) are large and a single noise monitoring location is used within each NCA to represent the whole acoustic climate therein. The monitoring locations are used to serve two purposes. That is, to establish background noise for setting appropriate criteria for construction and fixed plant noise assessment, and to establish the existing level of traffic noise for assessment of future traffic noise impacts. Noise monitoring for these two purposes often has conflicting monitor positioning requirements. This could lead to shortcomings in the impact assessment of construction and fixed plant noise, as often the monitoring location is the closest to the main roadway nearby (eg existing M4 alignment) and not further away where background noise levels will be lower. While traffic noise reduces by 3 dB per doubling of distance and construction or fixed plant by 6 dB per doubling of distance, accounting for shielding due to barriers or buildings could lead to greater reductions of traffic noise at say beyond two rows of houses from the road. This level of attenuation is not necessarily the same for construction sites and fixed plant sources (which could be considerably elevated as per the ventilation building for example).	In response to comments received during adequacy review, SMC provided the following information: RBLs are unlikely to be controlled by the nearest road as much as L_{Aeq} especially at night where traffic is not continuous. While the ventilation outlets would be elevated, the distance to the nearest receivers is such that these would remain as the worst affected. SMC agreed to some further field measurements to investigate the changes in the RBL at other locations in the NCA, to be undertaken during the EIS exhibition phase as per comments by RMS during teleconference 31.08.2015. Additional logger surveys have been undertaken. 15 noise loggers were deployed at various times between 13 and 26 October 2015. Review of any RBL adjustment can be made after subsequent analysis.	EMM has reviewed additional data and analysis of further noise monitoring as provided by the proponent (correspondence dated 10/12/12 and data supplied 23/12/15). Data at an additional 14 monitoring locations was obtained between 13 to 26 October 2015 (a 15th monitor malfunctioned). Additional monitoring was completed at 10 Welfare St, 38 Loftus Cr and 50 Underwood Rd Homebush, 18 Elliott St and 5 Carrington St North Strathfield, 5 Thornleigh Ave, 15 Edward St and 6 Loftus St Concord, 12 Luke Ave Burwood, 174 Queens Rd Canada Bay, 28 Page Ave Ashfield, 5 Wolseley St, 26 Walker Ave and 1 Walker Ave Haberfield. In most cases, a sufficient quantity of data, as defined by the INP, was collected. The main exception being 28 Page Ave where night time RBL data is based on only 4 samples (and does not therefore meet the INP's 7 sample minimum) due to extraneous influences (weather and other undefined sources). Adopting INP filters only or no filters, results in the same RBL derived from only 4 samples. Also, the adopted night RBL for this location is comparable to (and 2dB lower than) a nearby location (5 Wolseley St). Hence, derived RBLs are considered appropriately representative. This approach is considered adequate and addresses the issue of construction noise impacts. It is also expected that this data will be used to establish appropriate operational fixed plant noise criteria or otherwise additional data collected as part of the ONVMP.

Table C.1 Preliminary Review Comments – Noise and Vibration

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
1.2	Table 8 confirms via attended noise monitoring and observations that most monitoring locations were in environments dominated by heavy traffic noise from roads. Appendix C maps and photographs also confirm that monitors were positioned on property boundaries closest or most exposed to the M4 motorway or other road nearby, which ensures the monitors represent the noisiest position for the individual property and the whole NCA. For some locations (eg L5) the microphone is not in a free field environment as required for RBL determination for the purposes of construction and fixed plant noise impact assessment. The positioning of most of the monitors are suitable for traffic noise impact assessment and therefore possibly unsuitable for construction noise impact assessment. There are some exceptions to this whereby the monitors are positioned in locations specifically to address construction noise from proposed nearby compounds or work sites.	In response to comments received during adequacy review, SMC provided the following response: Loggers were located on the road side of the property as this is generally the position most exposed to both road traffic and construction noise, or located on the site side of the property as appropriate. Impacts at the adjacent receivers are considered to be captured by the assessment. No change. It is recognised that in an urban environment such as this, completely free field locations are not always available. Table 7 (note 3) indicates which loggers are identified as being clearly facade reflected. A facade correction is then applied to criteria based off the corresponding data.	The locations that are in a facade reflection zone must account for a 2.5 dB reduction before RBL values and corresponding construction and fixed plant operational noise criteria can be determined. It is unclear if this was done. Nonetheless, this is addressed in the draft recommended conditions.
1.3	The data in Appendix C demonstrates that RBL values are significantly lower when measurements are completed at locations further away from major roads. While relationships between distance from roadways and RBL values may not be possible, it is clear that consistently quieter areas exist away from main roads. For example, the data from four nearby monitoring stations presented in Appendix C show the two that are not exposed to the M4 or Parramatta Road are afforded a lower and the same daytime RBL of 41 dB (L7 and L9), while the other two (L6 and L8) RBLs are 48 dB and 55 dB respectively. That is, a considerable 14 dB difference in daytime RBL is measured between L8 to L7 or L9. This difference is not as significant, but still material at up to 7 dB (L8 to L9), at night when traffic volumes are lower. It is therefore plausible that other NCAs where single monitoring locations are used to represent the entire NCA for the purposes of construction noise impact assessment could lead to underestimation of impacts.	This would be the case for virtually every large infrastructure assessment using criteria based on RBLs as the large areas mean that an approximation is required for practicality reasons of deploying large numbers of loggers. 22 loggers were deployed for this project, which are at relatively close intervals in the study area. This number of monitoring locations is very high when compared to most other infrastructure projects even those with a greater linear study area. Generally, loggers were located on the source side of the receiver, and while this is typically also the road side, it would also be most likely to be the worst-impacted when assessed against RBLs. Additional logger surveys have been undertaken. 15 noise loggers were deployed at various times between 13 and 26 October 2015. Review of any RBL adjustment can be made after subsequent analysis.	Refer to 1.1 above.

Table C.1 Preliminary Review Comments – Noise and Vibration

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
1.4	The requirements for noise monitoring for the two purposes are stipulated in the ICNG (and INP) and RNP for construction (and operation) and road traffic noise respectively. The approach should also not result in overly conservative outcomes where RBL monitoring positions are less exposed to the chosen assessment location. An appropriate and representative balance needs to be achieved.	See response to 1.3.	Refer to 1.1 above.
2	Section 5.2 – Road noise prediction algorithms		
2.1	It is acknowledged that the adopted SoundPlan version 7.1 noise modelling software has been updated and is now at version 7.4. The NVIA states that since version 7.1, SoundPlan has not been verified for use on large infrastructure projects, and so newer versions have not been used. An explanation of differences between the two versions that could alter predicted levels, if relevant, should be provided. Alternatively, it should be confirmed that the calibration undertaken for the project model nullifies any such potential differences.	The calibration shows acceptable accuracy for the assessment. Preliminary analysis between the SoundPLAN versions shows an insignificant difference between the versions in terms of noise predictions. However, v7.4 takes anywhere between 4 and 8 times longer to run than v7.1. Since some of the noise calculations can take nearly one week to complete on state of the art server based systems (equivalent to 60 calculation cores) v7.4 is not used because of the time constraints involved. RMS confirms that v 7.4 is not practical for road noise model for the same reasons above and that v7.1 is preferred at this time. RMS concurs with SLR that v7.1 is appropriate for use on the M4 East EIS. Version 7.4 has been problematic to date.	Noted.
3	Section 5.4.7 – Noise model validation corrections		
3.1	The complexity of how corrections to predicted noise levels from congestion during the night period (10pm to 7am) are determined should be clarified, particularly when volumes would be appreciably lower than daytime.	Night-time period from 5am contains the majority of the night-time traffic, which also tends to exhibit congestion effects, hence the night-time corrections even with lower overall volumes than the daytime.	Noted.

Table C.1 Preliminary Review Comments – Noise and Vibration

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
	Table 11 indicates that the noise model underestimates free flowing traffic noise (Step 1) more often than not (17 of 24 predictions are underestimates).	Table 11 Step 1 indicates that the free flowing model is valid with all differences within acceptable random error limits of around 2 dBA or 1 standard deviation. The error is too small and the number of loggers too small to provide further comment on whether the median error is statistically different from zero. The error in Step 1 is acceptable and most likely due to limitations in the model or CoRTN. Calibration of the free flowing model is not required.	Noted.
	However, predictions for whole assessment periods (Step 2) overestimate more often than not (9 of 24 predictions are underestimates). The differences between Steps 1 and 2 are said to be related to traffic congestion factors.	The error in Step 2 has changed at each logger and in a direction that indicates the model now overestimates noise compared with free flowing traffic in Step 1. This combined with the lack of correlation between peak noise and peak traffic volumes in the logging graphs suggest that congestion is present and should be investigated for significance in Step 3. The test in Step 3 is used to provide certainty that the measured effects in Step 2 are significant and also not due to random error.	Noted.
	It would be valuable to show the measured noise levels for the free-flowing hours (Step 1) to better understand this process and possible difference between Step 1 and Step 2. Of particular interest is the M4 night congestion factor where a minus 2.1 (overestimation) median correction is determined.	This would not take into account the effects of congestion or random error. The likely outcome would be unaccounted for noise increase in the assessment and less >2 dBA mitigation triggers.	Noted.
	This logic should be further explained as it is not clear why for example Step 2 is not the model's validation factor for the period. The latter would give rise to a median validation factor for the M4 of minus 1.3 dB (ie overestimation by the model) as opposed to the adopted 2.1.	The median of the M4 Congestion Corrections is -2.1 dB hence adopted as the congestion correction - refer to Table 11. The corrections and congestion evaluation has been extensively reviewed by RMS and SLR to obtain the factors used in the assessment. The noise model was found to calibrate to within the acceptable tolerance. This means that further inspection of these corrections is not warranted. The end result of the correction analysis was to determine a calibrated model. This model has been used for the assessment.	Noted.

Table C.1 Preliminary Review Comments – Noise and Vibration

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
3.2	Expanding on the point above, looking closely at logger location L23, through an analysis of measured $L_{eq,night}$ noise levels (Table 13) and traffic volumes provided in Appendix F, an estimate of the free-flowing traffic noise level is determined to be 48 dBA. At this location, a night RBL of 49 dBA and L_{eq} of 57 dBA is presented at Appendix C. The charts show that L_{eq} noise levels do not drop below 51 dBA at night between midnight and 4am. These levels of ambient L_{eq} and background noise level could influence 'measured' traffic noise used to develop corrections in the model. Such issues should be investigated to determine whether they affect (conservatively or non-conservatively) the final correction factors used in the assessment.	See response to 3.1. If logger location L23 was reviewed and as an outcome excluded, the median error would still 2.1 dBA. Inclusion of L23 is inconsequential.	This response does not address the issue appropriately. However, it is expected that detailed design modelling will retest this issue as will the ultimate compliance testing post operations. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6.
3.3	Table 12 congestion corrections for Parramatta Rd and Wattle St appear to follow conflicting logic based on statistical significance of speed corrections (Step 3 in Table 11). For Parramatta Rd it is stated that there is 'negligible congestion on basis of speed' while for Wattle St it is stated that there is 'marginal congestion on basis of speed'. Yet Table 11 at Step 3 for night-time shows differences of -0.2 for Wattle St, the same value as shown for Parramatta Rd daytime differences. This should be explained as the implication could be that the correction value that should be adopted for Wattle St is nil and not -1.4 dB. Such correction factors although marginal, can result in a material difference in the number of properties afforded treatment as demonstrated at Figure 11 at Section 8.6 'Sensitivity analysis' (eg for 1 dB increase in predictions the number of properties eligible for at house mitigation increases by 51).	Measured and Step 3 check both show congestion at Wattle Street. This is not the case for Parramatta Road where the corrections based on measured levels do not all indicate congestion, and the step 3 check also shows less congestion on the basis of speed alone. This may be due to the interrupted nature of the flow on Parramatta Road (numerous traffic lights).	This response does not address the issue appropriately. However, it is expected that detailed design modelling will retest this issue as will the ultimate compliance testing post operations. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6.

Table C.1 Preliminary Review Comments – Noise and Vibration

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
4	Section 5.4.8 – Model validation summary		
4.1	There are five entries in each of the two night time 'differences' columns (ie 10 entries total) that are out by 0.1 dB. This should be explained (eg rounding errors etc.) and whether this alters the developed congestion corrections.	This is due to the rounding of the presented data. Both the levels and differences are taken from the unrounded values, and then rounded to 1dp, hence some differences of 0.1. No change to corrections.	Noted.
4.2	It is unclear whether the median difference between predicted and measured from Table 13 is applied globally to all roads, locations and periods or if the individual differences specific to each road, location and period were used later in the predicted levels. A note is provided beneath Table 16 (Note 4) at Section 5.15 that describes this, but further clarification is needed.	Refer to body of Table 16. Corrections applied to each road in the No Build scenario: Congestion Corrections (applied to all modelled source lines as a surface correction in the No Build Scenario only) M4 carriageway (day / night) Parramatta Road (day / night) Wattle Street (day / night) Concord Road (day / night)	Noted.
5	Section 5.6 – Modelling of traffic data		
5.1	The traffic volume data referred to (and provided at Appendix F) has not been specifically referenced from the Traffic and Transport assessment report. The Traffic and Transport report contains AM and PM peak volumes, ADT and AWT volumes for the M4, but not daytime 15-hour and night 9-hour volumes, nor volumes for free-flowing hours as adopted in the noise assessment. The traffic volume data should be appropriately referenced or sourced and assumptions used to derive volumes adopted in the noise assessment should be provided (eg how was 15-hour and 9-hour volumes for 'No build' and 'Build' cases derived from AWT data in the traffic assessment).	The data provided in the traffic and transport report does contain the AM and PM Peaks. The AM and PM Peak volumes are generally the worst time of the day and therefore traffic operational assessments are undertaken using these volumes. Information provided for air and noise assessments however need 15 hour and 9 hour day volumes to do their assessment. The WestConnex model is a four time period model i.e. an average one hour AM (average 7-9am), PM (3-6pm), Business (9am-3pm) and Night (6pm-7am) time model and these 4 models are used to calculate an Average Weekday Traffic (AWT) volume. The AWT volume is then proportioned into 15hr (i.e. AM/BUS/PM/proportion of Night) and 9hr (Proportion of Night) volumes. All of this information comes from the one model source and therefore is consistent throughout the EIS.	Noted.

Table C.1 Preliminary Review Comments – Noise and Vibration

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
6	Section 5.11 – Roads modelled in the assessment		
6.1	It appears that the M4 carriageway west of Homebush Bay Dr was not modelled for this project. It is understood that this was assessed as part of the M4 Widening project. However, it is unclear if the M4 Widening project accounted for traffic volumes as a consequence of the current project and others part of the WestConnex scheme. This section of road will likely see a change in traffic volume due to the current project, and residences to the south in the vicinity of the project boundary at this location could be affected. This issue should be clarified.	M4 East EIS assessed scenarios used No Build with No WCX and Build (10yr after opening) with Full WCX to account for the WCX scheme in the M4W study area (west of HBD).	Noted.
7	Section 5.13 – Receiver counts		
7.1	The statement relating to multi-level residential buildings and at property treatment applying to ground and first floor levels only is not entirely consistent with the Road Noise Policy (RNP). The RNP states at Table 7 "The external points of reference for measurement are the two floors of the building that are most exposed to traffic noise". In most cases the ground and first floors could be the most exposed. It is understood that this level of scrutiny is not feasible at this stage of the project, but if possible the assessment should identify where potential exists for other floors to be worst affected if relevant. Alternatively confirm that all 'most affected' two floors are the ground and first floor, or otherwise note that this will be the approach adopted in detailed design and in likely consent conditions should approval be granted.	Assessment based on RMS instruction and is consistent with current RMS approaches. The Road Noise Policy in Table 7 states the external points for reference, however this is different from identifying where noise mitigation should be applied. The Road Noise Policy, in its discussion of noise mitigation, provides reference to RMS processes to identify feasible and reasonable noise mitigation.	This issue will be addressed through draft recommended conditions. Upper floors should satisfy internal criteria as nominated in the RNP or as per AS2107 with windows closed.
8	Section 8.1 – Operation noise impacts without mitigation		
8.1	Noise contours for the M4 East alone should be provided (notwithstanding Appendix J) along the route for all cases modelled for $L_{eq,15hr}$ and $L_{eq,9hr}$. These contours will provide the reader with valuable graphic representation of 'No Build' vs 'Build' scenarios, particularly for the most exposed facade to the M4 alignment.	The graphic representation of 'No Build' vs 'Build' scenarios is already shown as the difference contour in Appendix J. The façade maps also show this information for each individual dwelling.	It is unclear whether Appendix J is for M4 East traffic noise in isolation of other roads. Nonetheless, this issue does not alter final assessment and identification of mitigation.

Table C.1 Preliminary Review Comments – Noise and Vibration

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
9	Section 8.1.2 – Receivers considered for additional noise mitigation		
9.1	This section is unclear with regard to the total number of receivers requiring additional mitigation. The figures of 76, 33 and 283 quoted to receive treatment total 392 (consistent with Table 18), however the overall total quoted is 400. Further clarification should be provided in respect of the 400 figure.	The 400 figure appears to be a value from a previous draft that was not manually corrected (typo). 392 is the correct figure (consistent with Table 18). This will be clarified in the Clarifications section of the Submissions Report.	Noted.
10	Section 8.4 – Operational noise impacts with mitigation		
10.1	It is stated that Appendix N tabulates predicted noise levels for all assessed locations. The table should include a legend identifying the various column headings that are abbreviated (eg T1_NB_D_RND and T1_FB_D_RND - this and other column headings are not totally clear and should be clarified).	This will be clarified in the Clarifications section of the Submissions Report.	Noted.
10.2	It is unclear if all assessed locations are listed in Appendix N. For example, NCA01 locations do not include 14 Welfare Street and 2 Flemington Road. These properties are located between the M4 and Parramatta Road and therefore within the assessment zone. Predictions are shown for these properties at Appendix M maps. This should be explained or these locations (and others as relevant) added to Appendix N.	All assessment locations shown in the maps are listed in Appendix N. It is noted that occasionally address information (from third party) is duplicated for multiple buildings if the dataset is not complete however the addresses at triggered receivers has been checked.	Noted.
10.3	A cross check between Appendix M maps and Appendix N table is not possible without the column headings being clarified. Using 12 Flemington Road as an example, Appendix M shows results for '2021 build with mitigation' of 61-63 dBA daytime and 56-58 dBA night. These results are consistent with more than one pair of columns in Appendix N, hence it is unclear to which columns these map results correspond.	Refer comment 10.1	Noted.

Table C.1 Preliminary Review Comments – Noise and Vibration

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
10.4	A similar table to that in Appendix N should be provided for the M4 project alone as received at the most exposed facade of dwellings to understand its contributions for the various options and the two years modelled. The presented results with respect to number of properties above or below criteria for build cases is skewed (when compared to no build) given the benefits of reduced traffic noise from a large section of Parramatta Road.	The 2021 Build scenario assessed in the noise report is described in section 5.1 of the N&V Report as follows: The forecast road traffic volumes at the nominal opening (2021) including the project as well as the approved M4 Widening and King Georges Road Interchange Upgrade projects.	Noted.
11	Section 8.7 – Maximum noise levels		
11.1	Discussions on typical increases in maximum noise levels is provided as a range of increases from 2 dBA to >10 dBA for six of the adopted NCAs. The upper end of the increases should be provided rather than an open ended >10 dBA reference.	This can be provided to DP&E, noting that max noise may change with any potential design revisions.	Noted. A response to this item was not received prior to finalising this review. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 conditions 27 to 29 and 31 to 33.
12	Section 9 – Ventilation facilities noise impact assessment		
12.1	This section requires additional detail to better contextualise the fixed sources and their closest receivers. In a typical industrial noise impact assessment, the 'site' would be detailed in a figure at a reasonable scale showing the specific location of noise items relative to the site boundary and its neighbours.	Refer to Figure 5.22 of the EIS shows the layout of the Eastern ventilation facility. Figure 5.20 of the EIS shows the layout of the Western ventilation facility.	Noted.
12.2	The above would then allow for a better justification to be constructed of whether the chosen representative assessment location and its representative logger location are appropriate (eg for developing noise criteria in accordance with the INP). This item relates back to Item 1 in this table and is particularly relevant to the ventilation facilities. That is, with a source 25m or 30m above ground, will the selected logger provide a representative background noise level for assessment of the potentially most exposed receivers.	The closest logger location was selected. Site layouts as per Item 12.1.	Noted. The additional monitoring noted in Item 1 will assist to resolve this issue.

Table C.1 Preliminary Review Comments – Noise and Vibration

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
13	Section 9.2.3 – Modifying factor adjustments		
13.1	The assumption adopted of no adjustment to plant noise (eg fans) due to sound characteristics in accordance with the Industrial Noise Policy (INP) should be justified through supportive data. Supportive spectral frequency data should be provided to justify this assumption and include the predicted spectrum at receivers, not only the at-source spectra as supplied in Table 26.	Based on the information available for the EIS assessment no correction factors were found to be necessary. Recommendations for future analysis to account for these factors were made and discussed as per Section 9.8.	Noted. Future assessments during detailed design must account for these characteristics as relevant.
14	Section 9.4 – Noise goal summary		
14.1	The amenity criteria adopted assumes all potentially affected residences are in 'urban' areas as defined in the INP. Justification should be provided as to why the INP 'suburban' category does not apply to some areas (eg further from the motorway) that could also be impacted by the fixed plant noise.	The study area fits the description of urban areas as per the INP.	Future assessments during detailed design must account for receiver categorisation as per the INP.
14.2	Table 25 lists the $L_{Aeq(Period)}$ Amenity criteria from the INP's Table 2.1 for the night period for urban residences. This criteria applies to all known industrial noise sources affecting a receiver currently and into the future. The assessment should confirm that all industrial noise sources have been considered in the derivation of criteria and therefore the assessment accounts for all industrial sources as required by the INP. The current approach is only valid if no other existing or known future industrial sources contribute to noise at receivers.	An urban night-time ANL of 45 dBA has been applied for the amenity criterion at all locations. This is due to the noise logging locations being adjacent to the road which results in the measured L_{Aeq} noise levels not being representative of all receivers in the catchment. The INP requires existing L_{Aeq} – 10 dB where it is dominated by traffic. The above approach was taken to account for receivers further back and to provide a conservative assessment.	This response does not address this issue. Future assessments during detailed design must account for existing industrial noise as per the INP for receivers further removed from the motorway. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.1 condition 1, Section 9.6 conditions 27 to 29 and 31 to 33.
15	Section 9.7 – Predicted noise impacts		
15.1	The predicted noise levels from fixed plant should include noise contours as provided for construction sites.	SMC will discuss this further and provide a response under separate cover.	Noted. A response to this item was not received prior to finalising this review. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 conditions 27 to 29 and 31 to 33.

Table C.1 Preliminary Review Comments – Noise and Vibration

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
15.2	The predicted received noise levels in Table 27 should include additional detail for adopted loss factors. For example, main portals jet noise is predicted to be 37 dBA (presumably at the nearest residence). Earlier the report states the model assumes four jet fans located 50m inside the tunnel and that main portals are 25 m from the nearest residence. The sound emission factor in Table 26 (109 dBA) converts to 115 dBA for four fans, reducing to 70 dBA at 75m (50m inside the tunnel plus 25m to the residence from the tunnel portal) based on standard point source distance loss only. Hence there is a further loss of 33 dB (70 less the predicted 37) due to other factors (eg tunnel lining, barrier, air absorption or other) that should be explained as this is a significant amount of energy loss. Again a diagrammatic or graphic showing relative locations of fans, portal and receiver should be provided to assist in demonstrating factors influencing these predictions.	Point source distance loss calculations will underestimate losses compared to the approach used by SLR. A summary of propagation losses is being prepared by SLR and will be provided to DP&E under separate cover.	Noted. A response to this item was not received prior to finalising this review. This issue is addressed through recommended conditions of approval, should the DP&E grant approval, at Section 9.6 condition 26.
15.3	A sound emission value is not provided for the ventilation and fresh air supply facilities, and instead a specification is provided for each needed to meet criteria. This is not an ideal assessment approach. Data from similar installations where such specifications are achieved should be provided. This may include at source emission values and insertion loss of required attenuation louvres etc. to give confidence in the assessment. Also, as above, the controlling criteria may change due to RBL values from additional monitoring locations and therefore alter the specifications presented.	Based on the information available for the EIS assessment the noise specification provided is considered sufficient. This information can be used by the contractor to determine if the finalised design is compliant. The facilities are viewed as having sufficient size to accommodate the very large and complex design of the fan attenuators. Beyond a review of the facilities sizing (to allow sufficient accommodation for noise mitigation in the detailed design) no further information can be provided. Without more detailed information a generic review has been provided. The specifics of the design of plant items must be completed at detailed design to comply with the established INP criteria. This would be refined during detailed design.	Future assessments during detailed design must account for this issue as relevant.

Table C.1 Preliminary Review Comments – Noise and Vibration

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
16	Section 9.8 – Predicted modifying factors		
16.1	Attenuators often change the frequency characteristics of the source they are attenuating. Hence, the INP low frequency or tonal penalties could apply to such sources. If such penalties are to apply, this puts further pressure on the design specification needed to meet criteria. Examples of tested plant should be provided to confirm, or otherwise, application of such penalties, and to provide confidence that criteria can be achieved.	The spec is recommended to be reviewed during detailed design and account for any applicable modifying factor - refer to Section 9.8 paragraph.	Future assessments during detailed design must account for these characteristics as relevant.
17	Section 10.4 – Noise management levels for construction activity		
17.1	As noted in Item 1, the position of noise monitors used for the construction noise assessment is unlikely to be suitable for construction assessment given monitors were generally in the noisiest position within the NCAs. Therefore the assessment of construction noise may not have been completed in accordance with the ICNG. Justification should be provided for the use of the monitoring data for this purpose, or alternate data collected.	Refer to Items 1.1, 1.2, 1.3.	As above for Item 1
18	Section 10.5.1 – Construction equipment		
18.1	Table 31 provides 'Sound Power Level (dBA)' by 'item', 'activity' and 'LWAmix activity'. Explanations or definitions of each of these terms should be provided. The addition of the items for some scenarios matches the 'activity', yet for other scenarios matches the 'LWAmix activity' and therefore indicating a possible inconsistency in the approach requiring clarification.	LWA,item refers to the LAeq sound power level from the individual item of plant (when operating). LWA,activity refers to the combined LAeq sound power level of the group of plant items assumed to be operating within the same (approximate) location as part of the given scenario. LWAmix refer to the LAmix sound power level. We have not identified an inconsistency but can look at a specific example if one can be provided.	Noted.
18.2	Table 31 nominates open-ended durations as '> 6 months'. An upper estimate of such works should be provided, eg '>6months to 18 months' to better inform the community.	SMC has provided this to the contractor, LSJH, for response. This will be forwarded under separate cover.	Noted. A response to this item was not received prior to finalising this review.

Table C.1 Preliminary Review Comments – Noise and Vibration

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
19	Section 10.6 – Noise assessment at the nearest sensitive receivers		
19.1	This section clearly demonstrates that significant noise level exceedances are expected due to the project and across many areas of works. The quoted worst case levels being '>90 dBA' and the like should be better defined and include specific predicted levels.	Where predicted noise levels were >90 dBA the assessment generally triggers the upper end of the feasible and reasonable noise mitigation (ie >25 dB above NML) and so displaying higher levels would not add to the assessment. Noise levels greater than this are generally very short lived at the very outer extents of the construction footprint. Predictions will be refined during construction planning when further detail is known. It is likely that some areas of the construction footprint would not require operation of all plant items (hence reducing noise impact). The approach used to model construction noise impacts from multiple plant items is also conservative at close distances and will overestimate noise levels.	Future assessments during detailed design must address this issue as relevant.
20	Section 10.7 – Cumulative noise impacts		
20.1	The statements made in this section with regard to why cumulative noise impacts have not be predicted for some activities is unclear. It is stated that "...plant and equipment will move about the worksites and will not all be operating concurrently...". This explanation would apply equally to predictions that have been provided for individual work sites in previous sections and hence requires additional clarification. Alternatively, predictions for overlapping activities across all work sites should be provided to quantify the potential noise impacts at receivers.	For main corridor works, the worst-case impacts are highest from one scenario when it is working at the closest point to a receiver. This controls the assessment. Other variations at a lower noise levels are possible from cumulative impacts when works are further from any given receiver, however this would represent a lower level of impact than the worst-case assessed. For compounds/tunnel sites, the worst-case noise levels for receivers located between two sites may be influenced by more than one compound, hence compounds/tunnel sites were modelled also for cumulative noise. For this project cumulative noise from compound/tunnel sites was not found to significantly increase noise at sensitive receivers.	Noted.

Table C.1 Preliminary Review Comments – Noise and Vibration

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
21	Section 10.8.3 – Construction noise mitigation measures		
21.1	Acoustic building enclosures at tunnelling sites is said to reduce noise by up to 22 dB. Maps in Appendix R for without and with mitigation do not reflect such reductions and in many cases these maps show noise contours to be largely unchanged. This should be explained further.	Daytime scenarios at the sites have scenarios outside the sheds hence shed breakout does not always dominate the noise at the receivers. Night-time maps in Appendix R5 show a significant benefit due to the sheds which has been identified as up to 22 dB (refer Concord site) however this is dependent on factors such as field of view of receiver to the elements of the shed and distance to the shed.	Future assessments during detailed design must consider this issue as relevant.
22	Section 11.2 – Construction traffic noise assessment		
22.1	Table 51 should include existing and proposed traffic volumes and noise levels. It should also state actual noise level changes that are shown presently as '>2 dB'.	Refer to table note 2 - existing traffic volumes were not available on these local roads however a (conservative) estimate was made based on an assumption of minimal existing heavy vehicle flows on these roads hence a noticeable increase in noise (ie denoted as > 2 dB).	Noted. Future assessments during detailed design must consider this issue as relevant.
23	Section 12.5 – Excavation of main tunnels		
23.1	The predictions presented should include discussion on whether multiple roadheaders will be used concurrently and if cumulative impacts from such activities are possible and if so, whether this has been included in the presented predictions.	Prediction of vibration and ground borne noise is variable in nature and is indicative of the likely impacts. There will always be large separation distance between vibration sources due to safety constraints when working under ground. The vibrations from concurrent sources would need to be perfectly phased and frequency matched to see additive effects. This is highly unlikely to occur.	Noted.
24	Section 12.7 – Ground-borne noise mitigation		
24.1	Information on whether the presented exceedances align with receptors also identified as being highly affected from air borne construction noise (ie 75 dBA) should be provided, and therefore whether alternate accommodation should be a mitigation option for ground borne noise exceedances.	The airborne and ground borne exceedances are not required to be combined to determine mitigation. The ICNG provides residential NMLs for ground-borne noise, which are applicable when ground-borne noise levels are higher than the corresponding airborne construction noise levels. The requirement for mitigations strategies including alternative accommodation would be confirmed at the construction planning phase.	For clarification, the comment was not inferring that the airborne and ground borne noise be additive to define mitigation. Nonetheless, future assessments during detailed design must consider this issue as relevant.

Table C.1 **Preliminary Review Comments – Noise and Vibration**

Item	EMM comment	Proponent Response (12/11/15)	EMM final review
25	Section 13.8 – Blasting		
25.1	Potential blasting vibration levels should be provided for representative assessment locations (ie nearest to tunnel cross passages or where benching is likely).	Nearest receivers are at 30 m from the works as per the assessment. The representative receivers are therefore included within the assessment at 30m as per Section 13.8.4.	Noted.



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