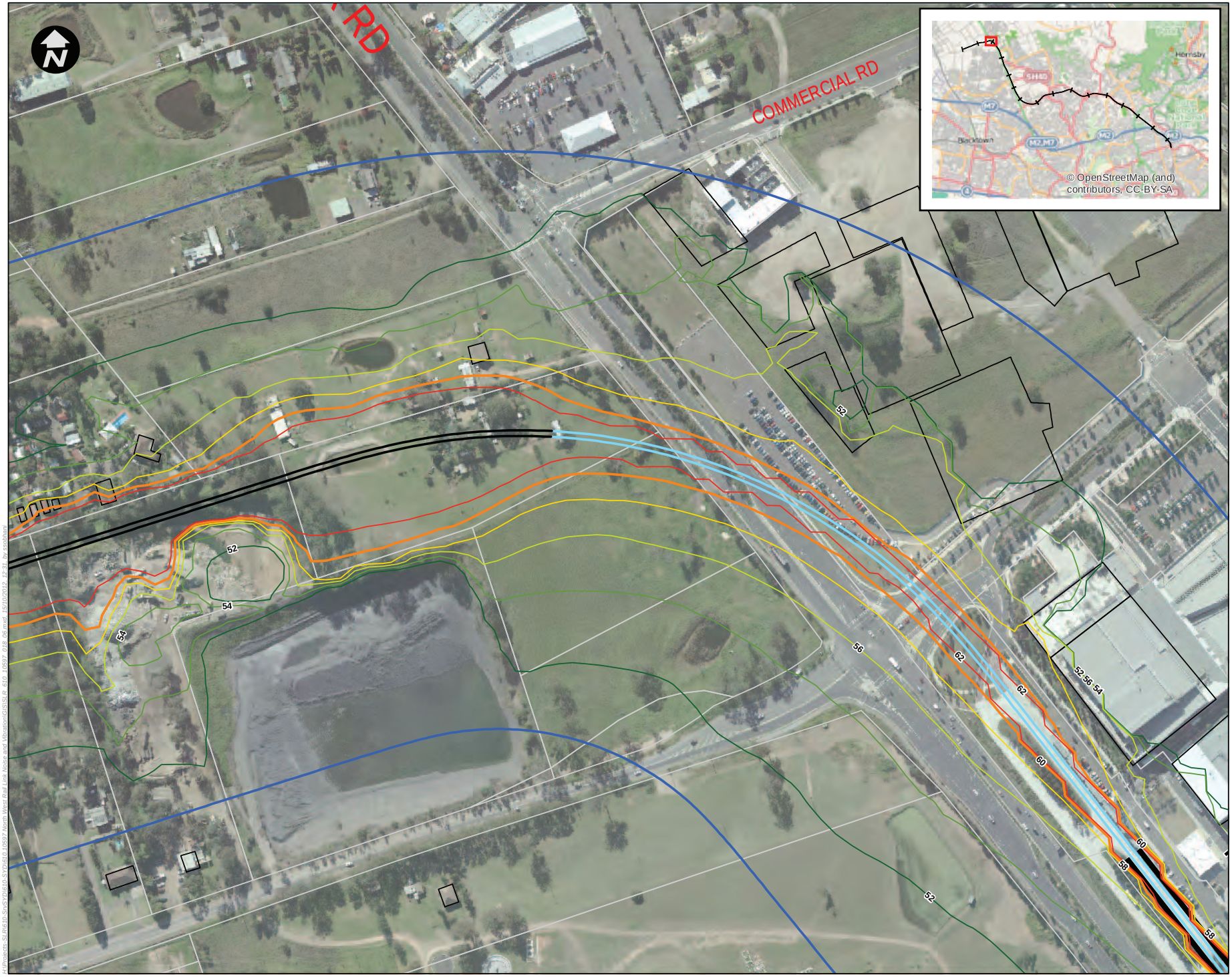
Sheet 8

NWRL Airborne Noise - $L_{Aeq\ (15hour)}$ Daytime



LEGEND

- NWRL Surface Track
- NWRL Viaduct
- Modelled Building Outline
- Calculation Area

L_{Aeq}

- 52 dBA
- 54 dBA
- 56 dBA
- 58 dBA
- 60 dBA
- 62 dBA

0 12.5 25 50 75 100
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Digital Cadastral Database © LPMA 2012
3. IGANRIP $L_{Aeq\ (15hour)}$ trigger level is 60 dBA
4. Noise contours calculated at 4.5m above ground

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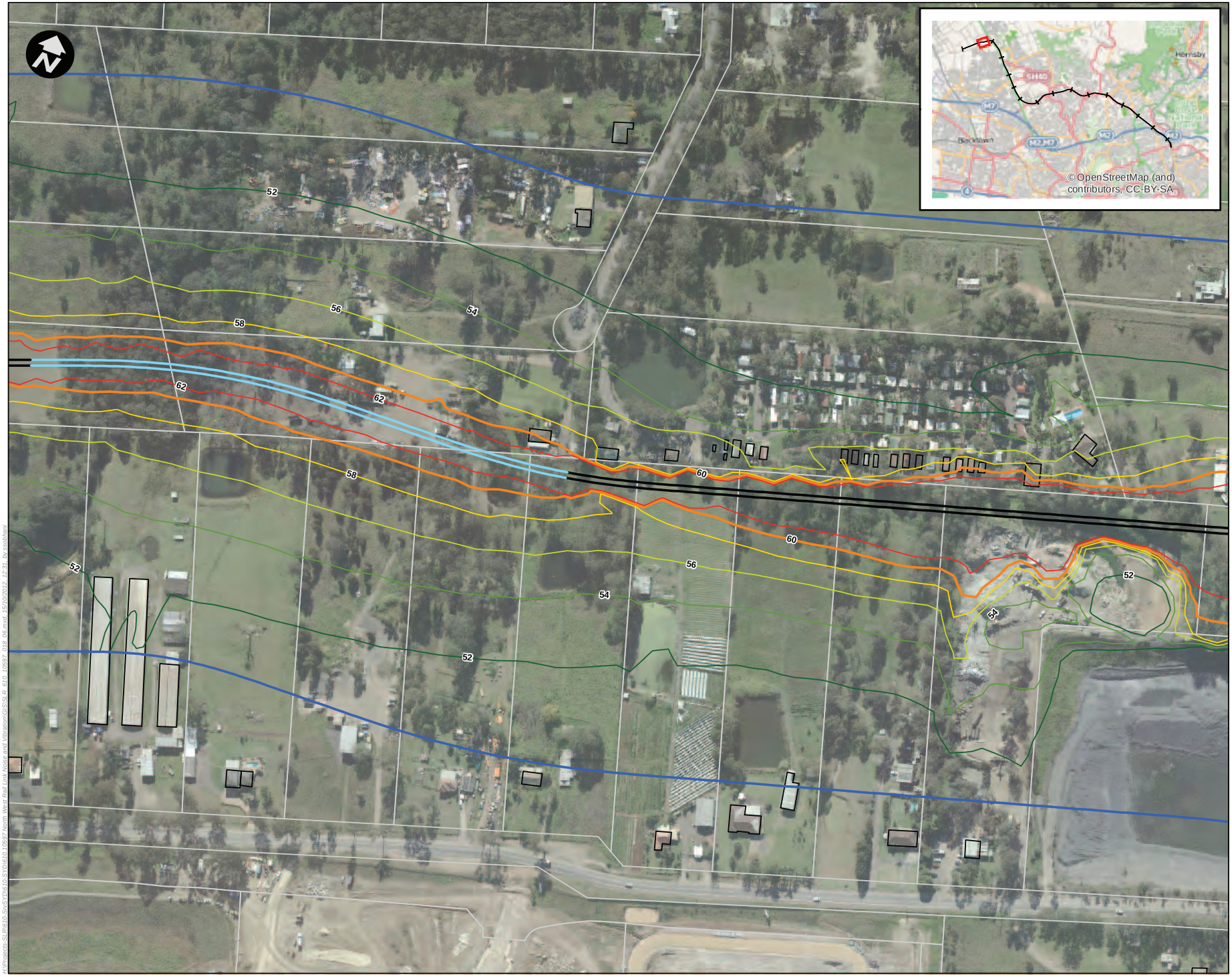
Sheet 9

NWRL Airborne Noise - $L_{Aeq\ (15hour)}$ Daytime



LEGEND

- NWRL Surface Track
- NWRL Viaduct
- Modelled Building Outline
- Calculation Area

L_{Aeq}

- 52 dBA
- 54 dBA
- 56 dBA
- 58 dBA
- 60 dBA
- 62 dBA

0 12.5 25 50 75 100
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Digital Cadastral Database © LPMA 2012
3. IGANRIP $L_{Aeq\ (15hour)}$ trigger level is 60 dBA
4. Noise contours calculated at 4.5m above ground

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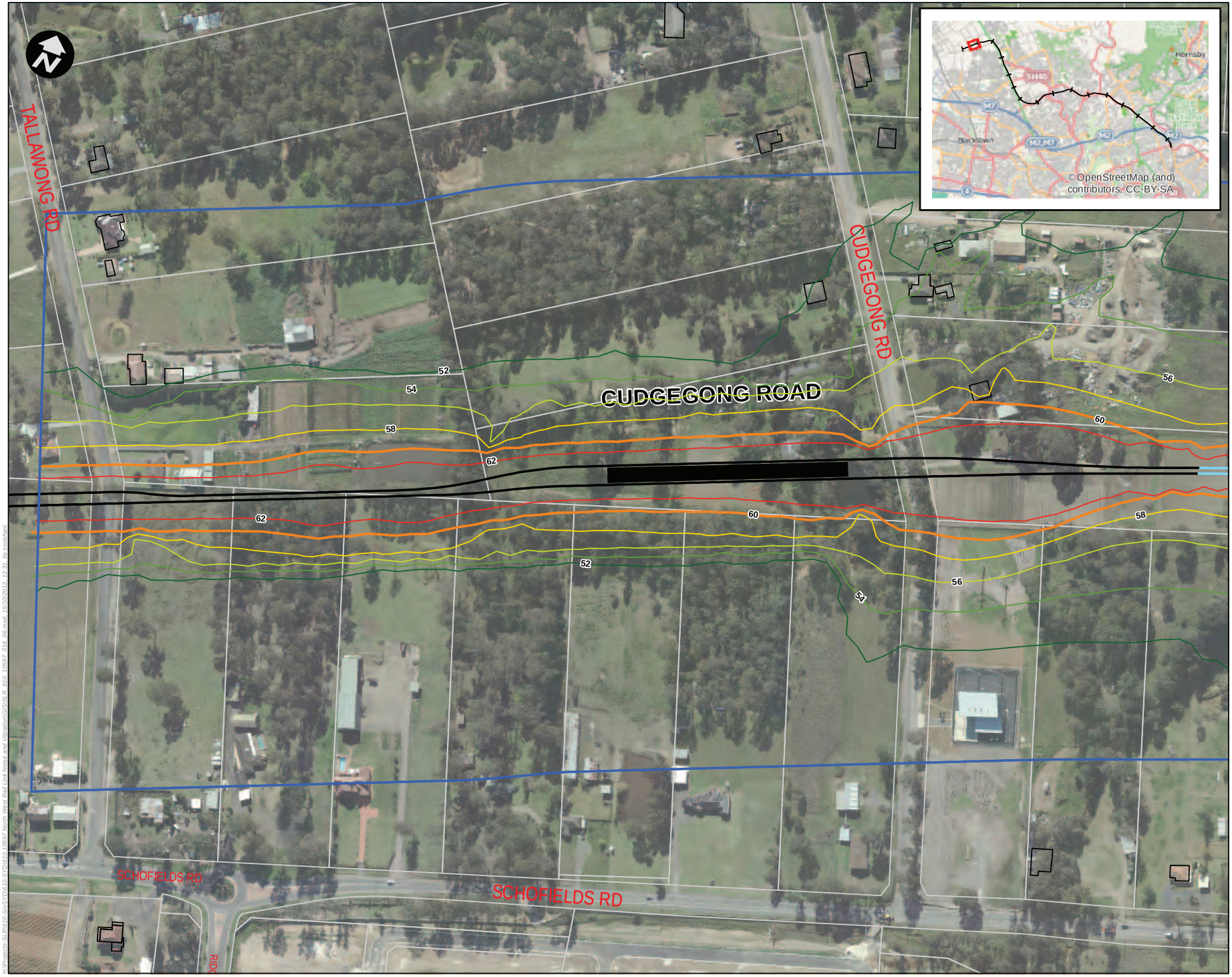
Sheet 10

NWRL Airborne Noise - $L_{Aeq\ (15hour)}$ Daytime



LEGEND

- NWRL Surface Track
- NWRL Viaduct
- Modelled Building Outline
- Calculation Area

L_{Aeq}

- 52 dBA
- 54 dBA
- 56 dBA
- 58 dBA
- 60 dBA
- 62 dBA

0 12.5 25 50 75 100
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Digital Cadastral Database © LPMA 2012
3. IGANRIP $L_{Aeq\ (15hour)}$ trigger level is 60 dBA
4. Noise contours calculated at 4.5m above ground

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Sheet 1

NWRL Airborne Noise - $L_{Aeq\ (9hour)}$ Night-time

LEGEND

- NWRL Surface Track
- NWRL Tunnel Track
- Modelled Building Outline
- Calculation Area

L_{Aeq}

- 47 dBA
- 49 dBA
- 51 dBA
- 53 dBA
- 55 dBA
- 57 dBA

0 12.5 25 50 75 100
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Digital Cadastral Database © LPMA 2012
3. IGANRIP $L_{Aeq\ (9hour)}$ trigger level is 55 dBA
4. Noise contours calculated at 4.5m above ground

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Sheet 2

NWRL Airborne Noise - $L_{Aeq\ (9hour)}$ Night-time

LEGEND

- NWRL Surface Track
- NWRL Viaduct
- Modelled Building Outline
- Calculation Area

L_{Aeq}

- 47 dBA
- 49 dBA
- 51 dBA
- 53 dBA
- 55 dBA
- 57 dBA

0 12.5 25 50 75 100
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Digital Cadastral Database © LPMA 2012
3. IGANRIP $L_{Aeq\ (9hour)}$ trigger level is 55 dBA
4. Noise contours calculated at 4.5m above ground

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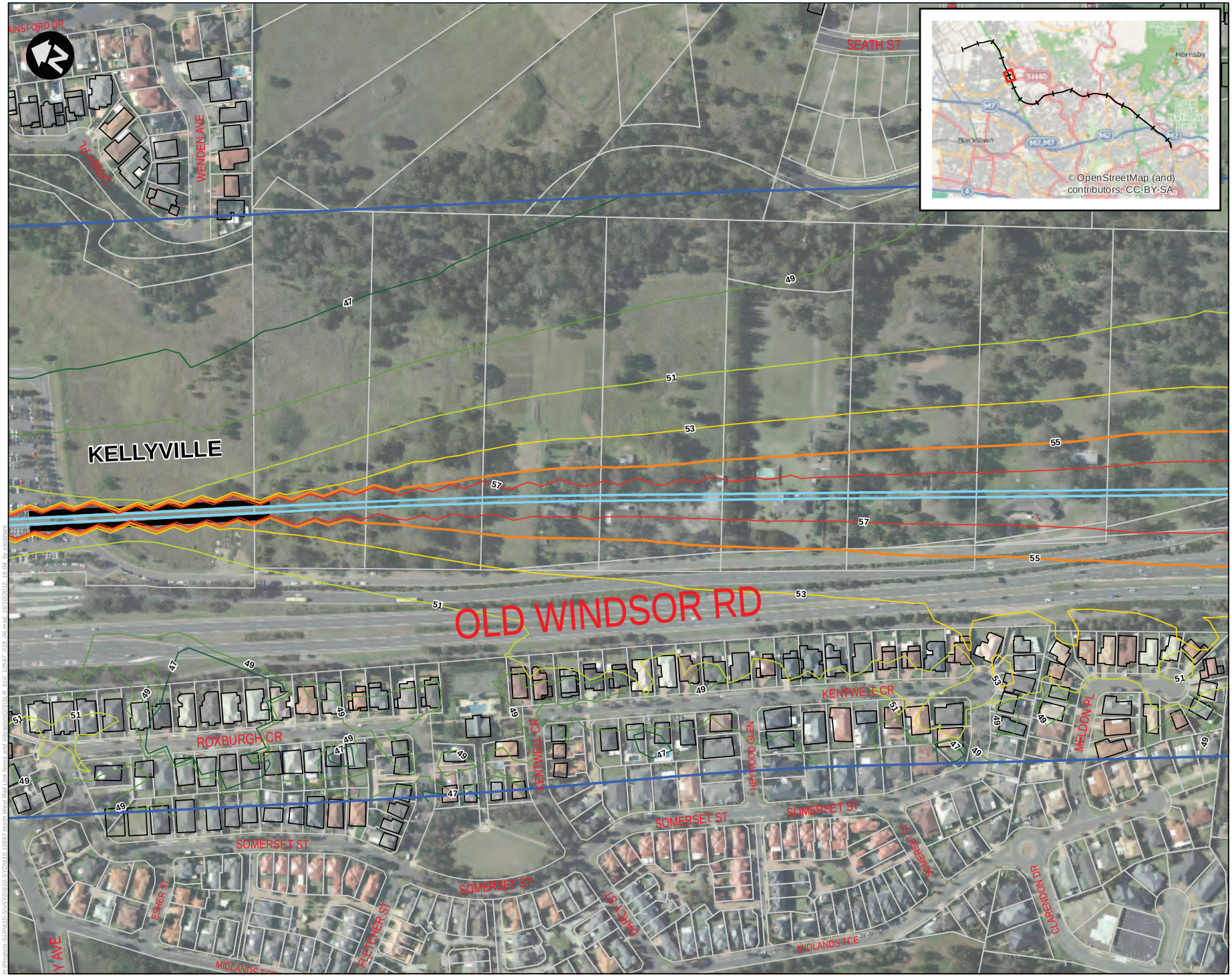
Sheet 3

NWRL Airborne Noise - $L_{Aeq\ (9hour)}$ Night-time



LEGEND

- NWRL Viaduct
- Modelled Building Outline
- Calculation Area

L_{Aeq}

- 47 dBA
- 49 dBA
- 51 dBA
- 53 dBA
- 55 dBA
- 57 dBA

0 12.5 25 50 75 100
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Digital Cadastral Database © LPMA 2012
3. IGANRIP $L_{Aeq\ (9hour)}$ trigger level is 55 dBA
4. Noise contours calculated at 4.5m above ground

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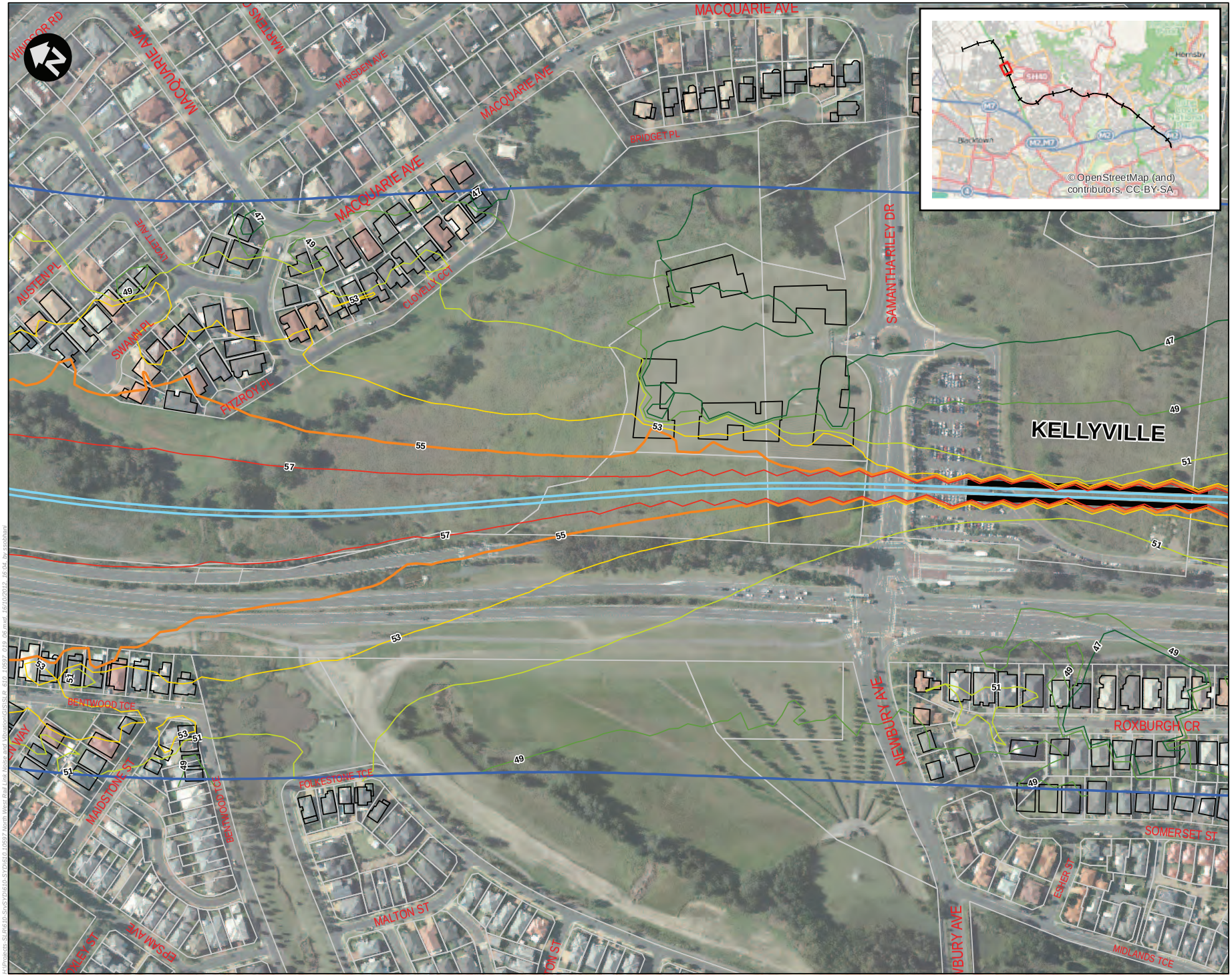
Sheet 4

NWRL Airborne Noise - $L_{Aeq\ (9hour)}$ Night-time



LEGEND

- NWRL Viaduct
- Modelled Building Outline
- Calculation Area

L_{Aeq}

- 47 dBA
- 49 dBA
- 51 dBA
- 53 dBA
- 55 dBA
- 57 dBA

0 12.5 25 50 75 100
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Digital Cadastral Database © LPMA 2012
3. IGANRIP $L_{Aeq\ (9hour)}$ trigger level is 55 dBA
4. Noise contours calculated at 4.5m above ground

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Sheet 5

NWRL Airborne Noise - $L_{Aeq\ (9hour)}$ Night-time

LEGEND

- NWRL Viaduct
- Modelled Building Outline
- Calculation Area

L_{Aeq}

- 47 dBA
- 49 dBA
- 51 dBA
- 53 dBA
- 55 dBA
- 57 dBA

0 12.5 25 50 75 100
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Digital Cadastral Database © LPMA 2012
3. IGANRIP $L_{Aeq\ (9hour)}$ trigger level is 55 dBA
4. Noise contours calculated at 4.5m above ground

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Sheet 6

NWRL Airborne Noise - $L_{Aeq\ (9hour)}$ Night-time

LEGEND

- NWRL Viaduct
- Modelled Building Outline
- Calculation Area
- L_{Aeq}
  - 47 dBA
  - 49 dBA
  - 51 dBA
  - 53 dBA
  - 55 dBA
  - 57 dBA

0 12.5 25 50 75 100
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Digital Cadastral Database © LPMA 2012
3. IGANRIP $L_{Aeq\ (9hour)}$ trigger level is 55 dBA
4. Noise contours calculated at 4.5m above ground

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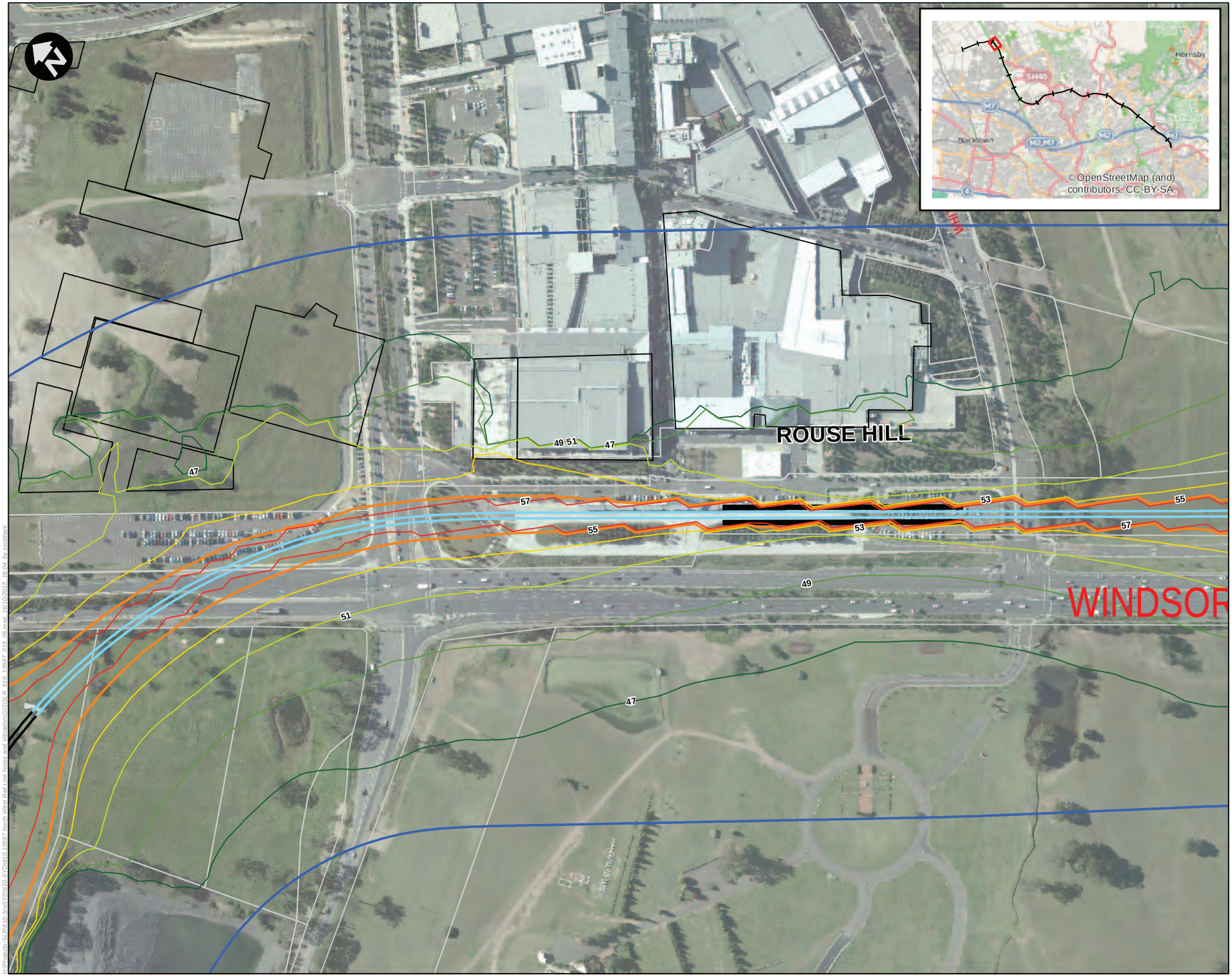
Sheet 7

NWRL Airborne Noise - $L_{Aeq\ (9hour)}$ Night-time



LEGEND

- NWRL Surface Track
- NWRL Viaduct
- Modelled Building Outline
- Calculation Area

L_{Aeq}

- 47 dBA
- 49 dBA
- 51 dBA
- 53 dBA
- 55 dBA
- 57 dBA

0 12.5 25 50 75 100
Metres

NOTES

1. Aerial photography © Transport for NSW
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3. IGANRIP $L_{Aeq\ (9hour)}$ trigger level is 55 dBA
4. Noise contours calculated at 4.5m above ground

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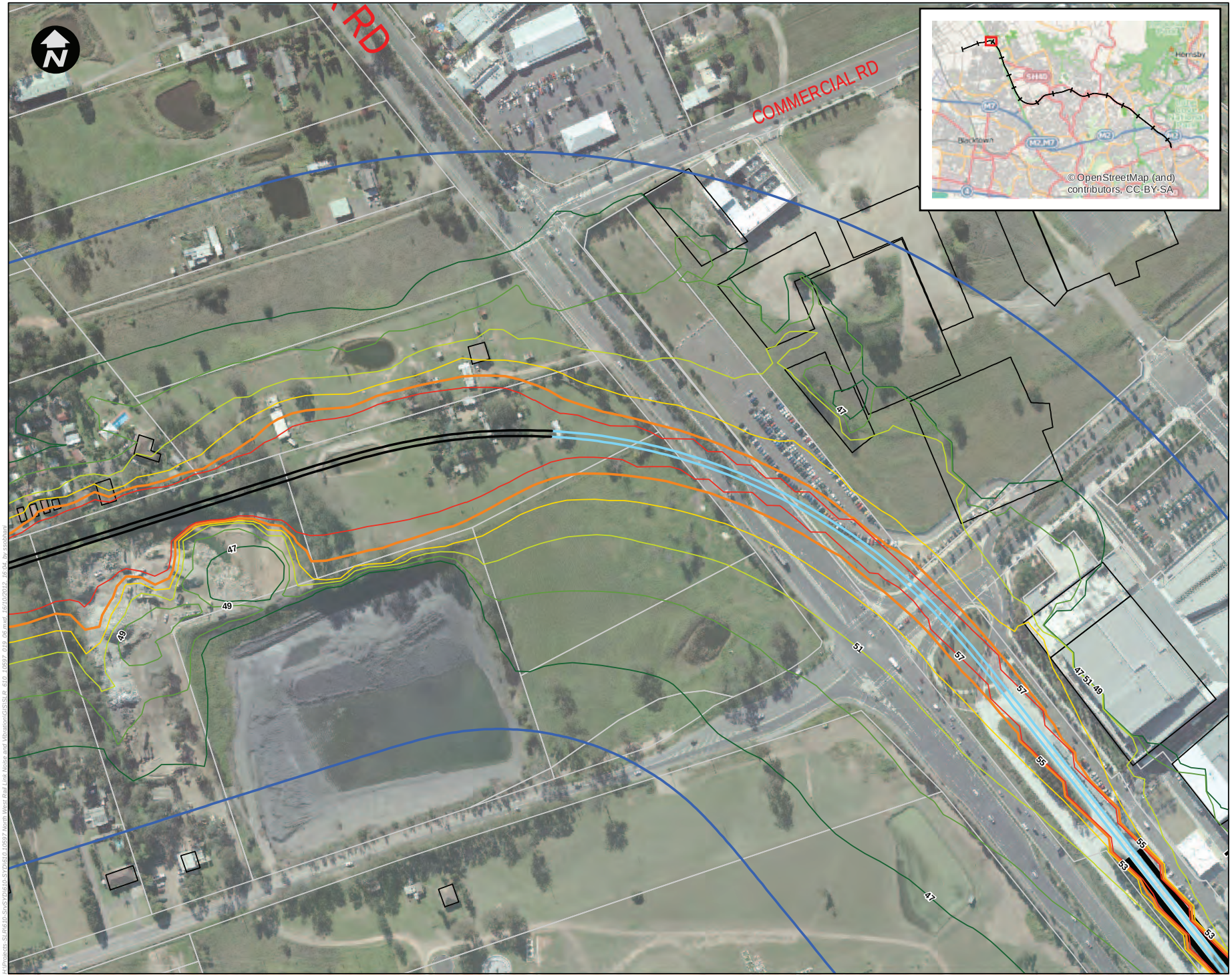
Sheet 8

NWRL Airborne Noise - $L_{Aeq\ (9hour)}$ Night-time



LEGEND

- NWRL Surface Track
- NWRL Viaduct
- Modelled Building Outline
- Calculation Area

L_{Aeq}

- 47 dBA
- 49 dBA
- 51 dBA
- 53 dBA
- 55 dBA
- 57 dBA

0 12.5 25 50 75 100
Metres

NOTES

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2. Digital Cadastral Database © LPMA 2012
3. IGANRIP $L_{Aeq\ (9hour)}$ trigger level is 55 dBA
4. Noise contours calculated at 4.5m above ground

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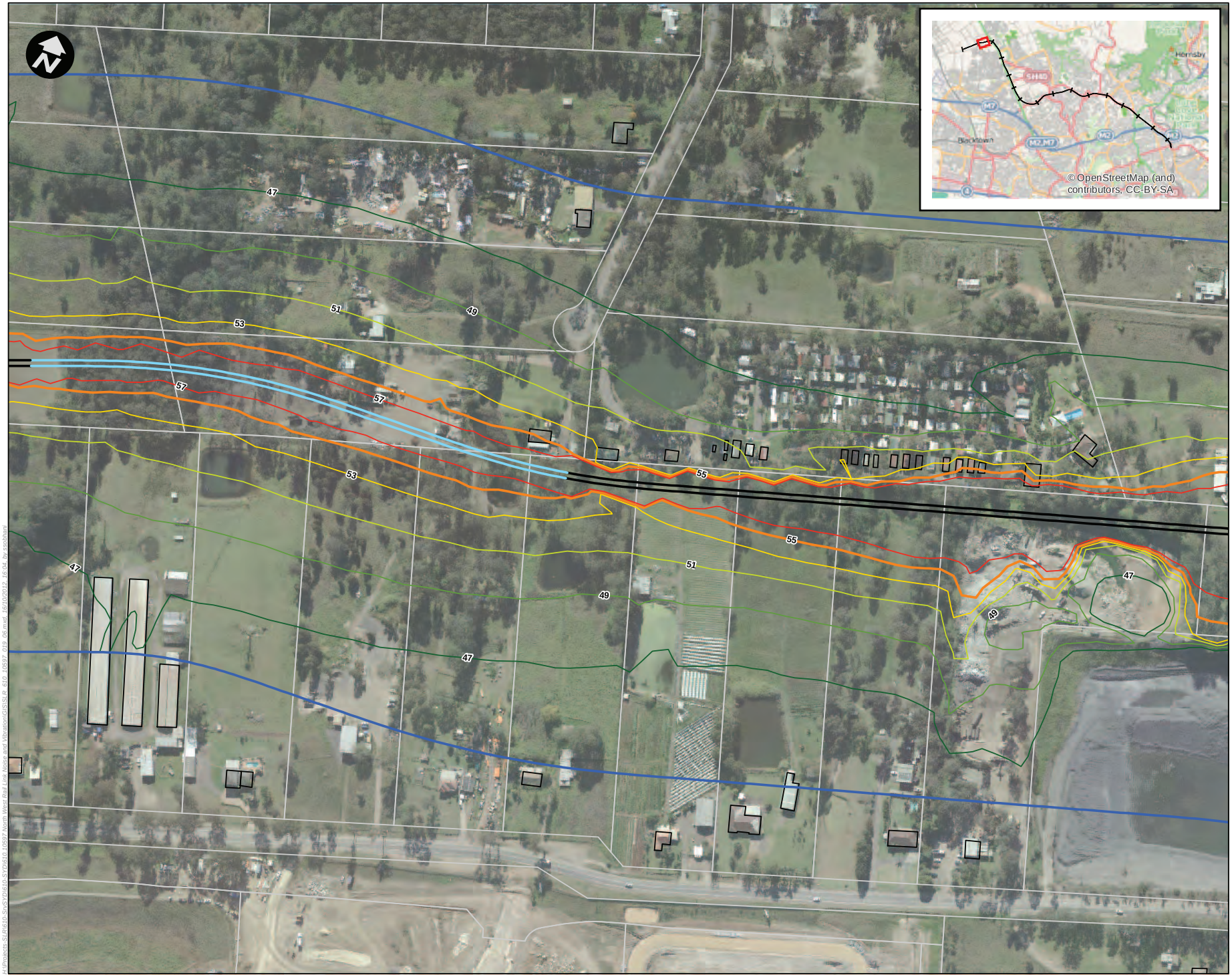
NWRL Airborne Noise - $L_{Aeq\ (9hour)}$ Night-time



LEGEND

- NWRL Surface Track
- NWRL Viaduct
- Modelled Building Outline
- Calculation Area

L_{Aeq}

- 47 dBA
- 49 dBA
- 51 dBA
- 53 dBA
- 55 dBA
- 57 dBA

0 12.5 25 50 75 100
Metres

NOTES

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2. Digital Cadastral Database © LPMA 2012
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4. Noise contours calculated at 4.5m above ground

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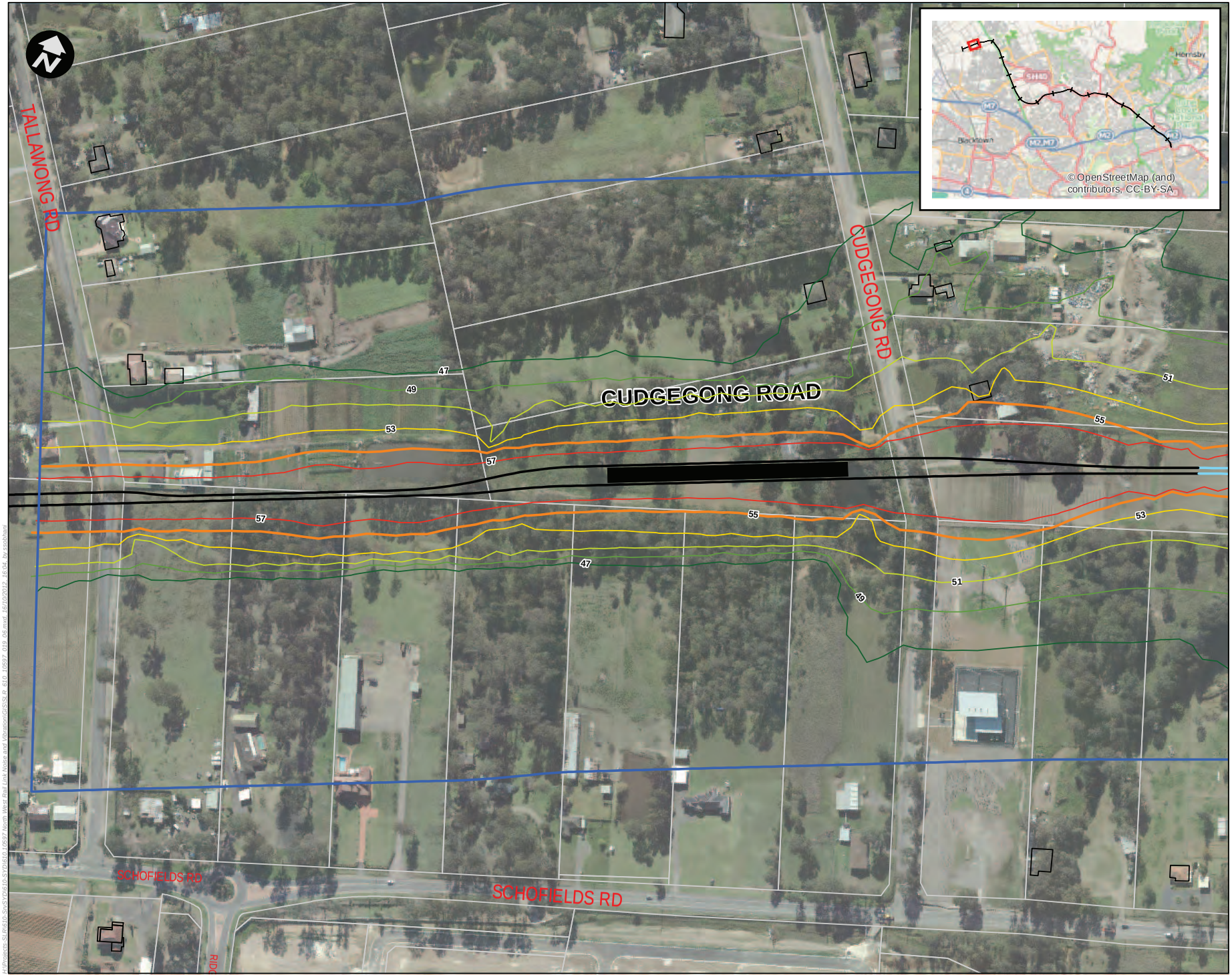
NWRL Airborne Noise - $L_{Aeq\ (9hour)}$ Night-time



LEGEND

- NWRL Surface Track
- NWRL Viaduct
- Modelled Building Outline
- Calculation Area

L_{Aeq}

- 47 dBA
- 49 dBA
- 51 dBA
- 53 dBA
- 55 dBA
- 57 dBA

0 12.5 25 50 75 100
Metres

NOTES

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3. IGANRIP $L_{Aeq\ (9hour)}$ trigger level is 55 dBA
4. Noise contours calculated at 4.5m above ground

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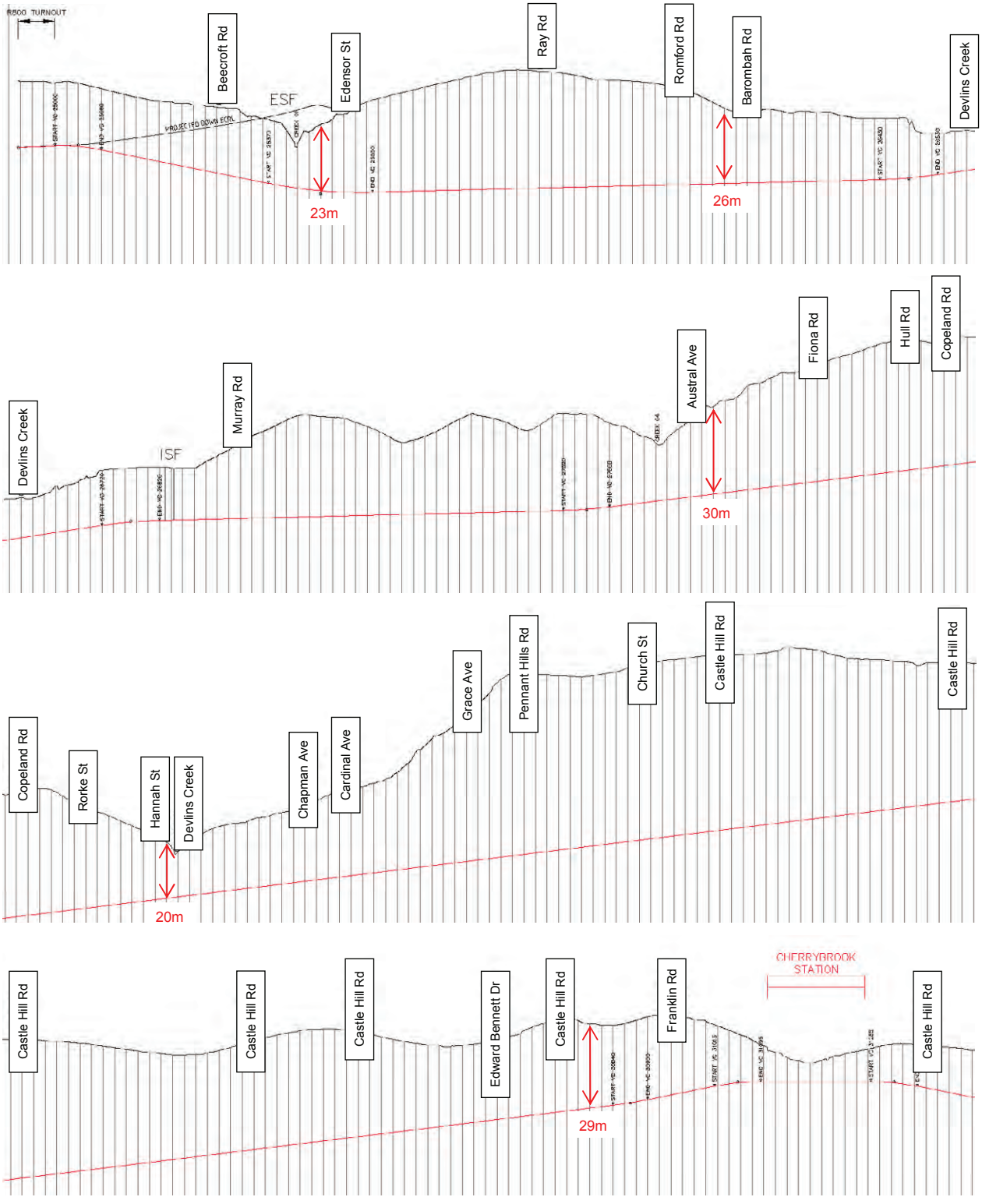
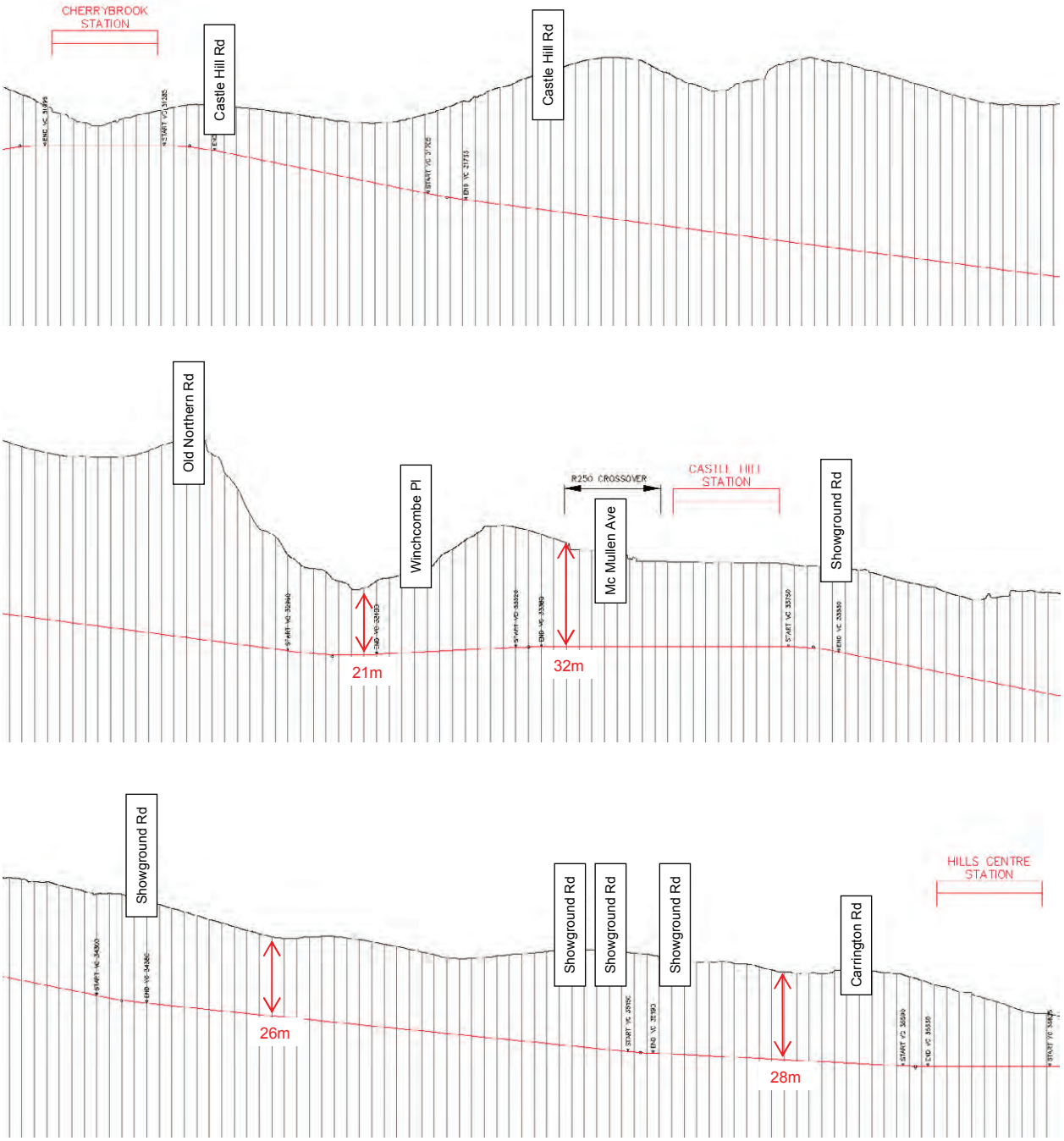
Appendix F Long Sections of Underground Tunnels

Epping to Cherrybrook

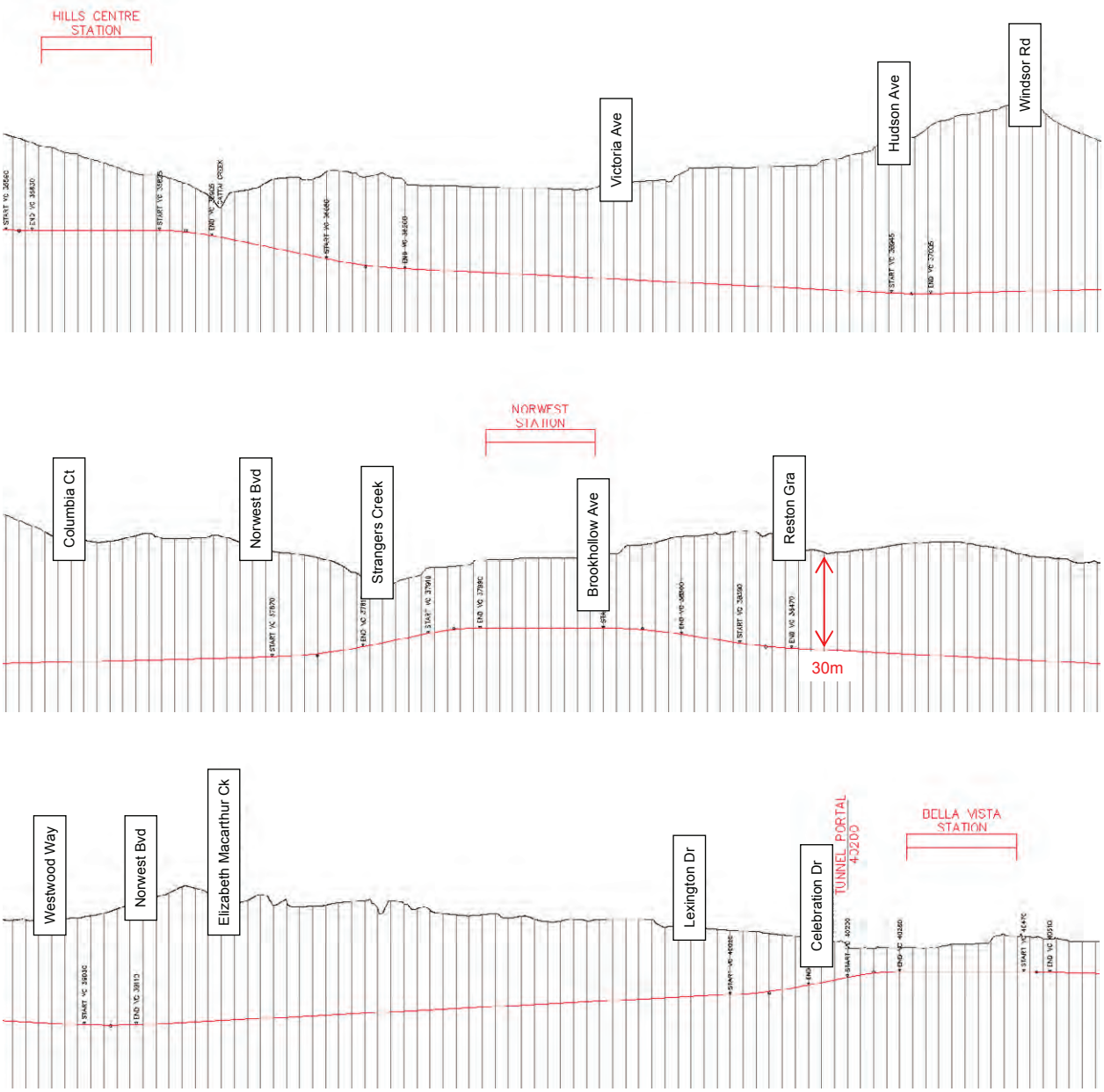


Cherrybrook to Showground



Note: Hills Centre Station has been renamed to Showground Station

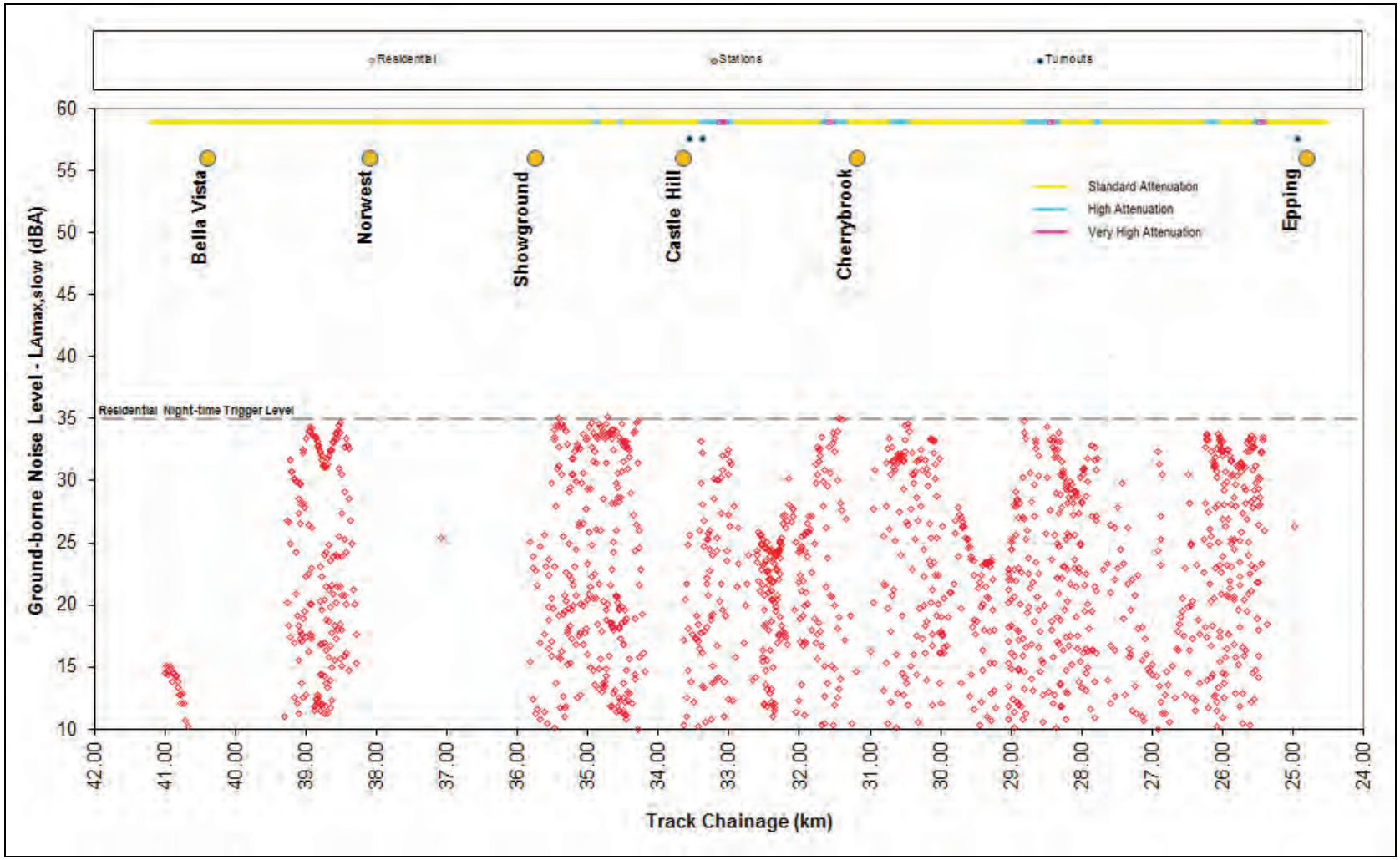
Showground to Bella Vista

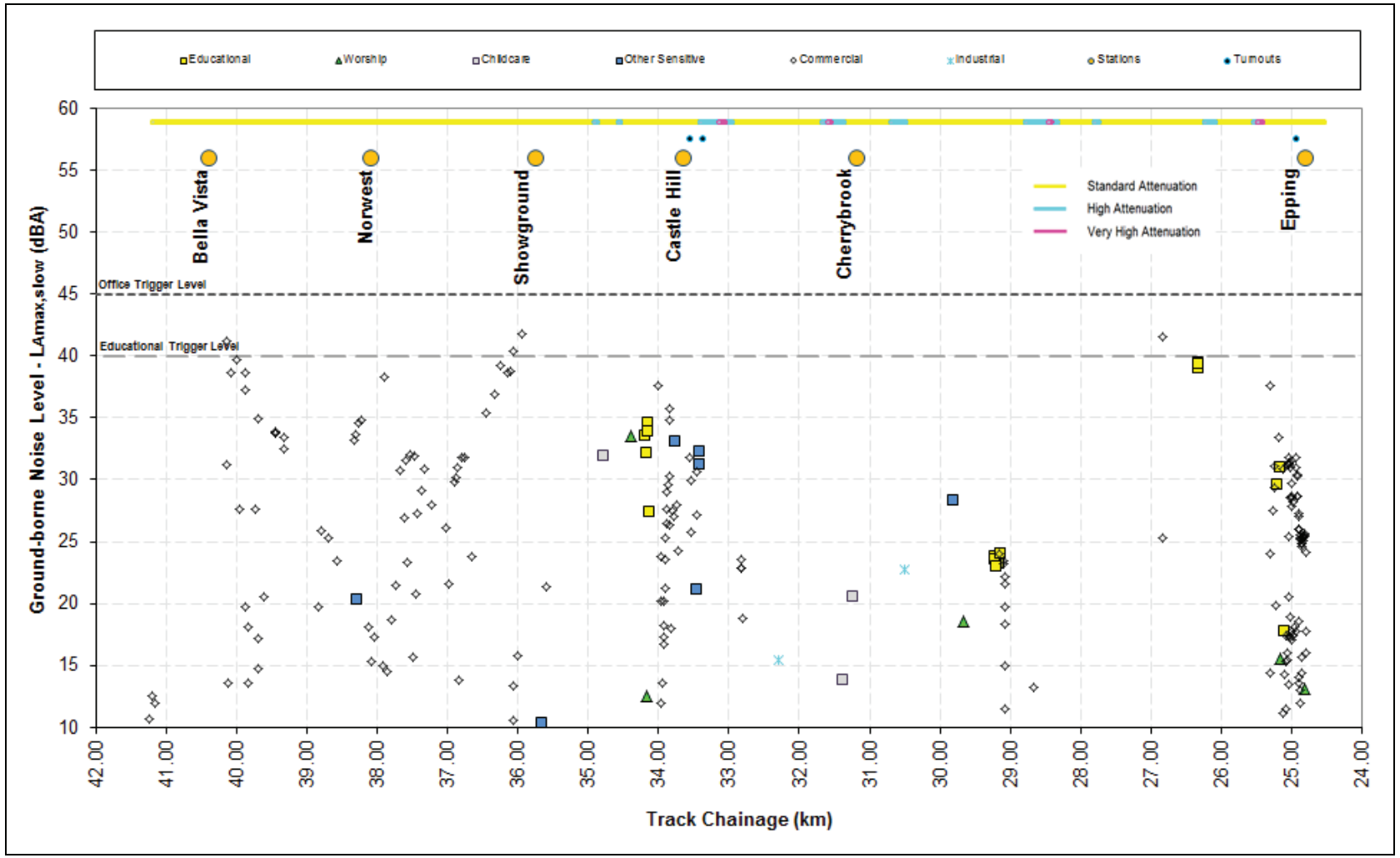


Note: Hills Centre Station has been renamed to Showground Station

Appendix G Ground-borne Noise from Rail Operations

The following charts provide a summary of the predicted ground-borne noise levels for the proposed tunnel alignment versus track chainage.




Educational
Worship
Childcare
Other Sensitive
Commercial
Industrial
Stations
Turnouts
Bella Vista
Norwest
Showground
Castle Hill
Cherrybrook
Epping
Standard Attenuation
High Attenuation
Very High Attenuation
Office Trigger Level
Educational Trigger Level
Ground-borne Noise Level - LAmax,slow (dBA)
Track Chainage (km)
60
55
50
45
40
35
30
25
20
15
10
42.00
41.00
40.00
39.00
38.00
37.00
36.00
35.00
34.00
33.00
32.00
31.00
30.00
29.00
28.00
27.00
26.00
25.00
24.00

Appendix H Stabling Facility Noise Contours

Scenario 1

Stabling and Maintenance Facility Operational Noise – Brake Air Release L_{Amax}

LEGEND

- Modelled Building Outline
- Maintenance Facility Buildings
- NWRL Acquired Land
- Indicative Stabling Area

L_{Amax}

- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA
- 55 dBA
- 60 dBA
- 65 dBA

0 25 50 100 150 200
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Noise contours calculated at 1.5m above ground level
3. L_{Amax} sleep disturbance criterion is 50 dBA for the night-time and early morning periods
4. Noise contours are a worse-case composite of all possible source locations
5. Digital Cadastral Database © LPMA 2012
6. Noise contours calculated with adverse meteorological conditions

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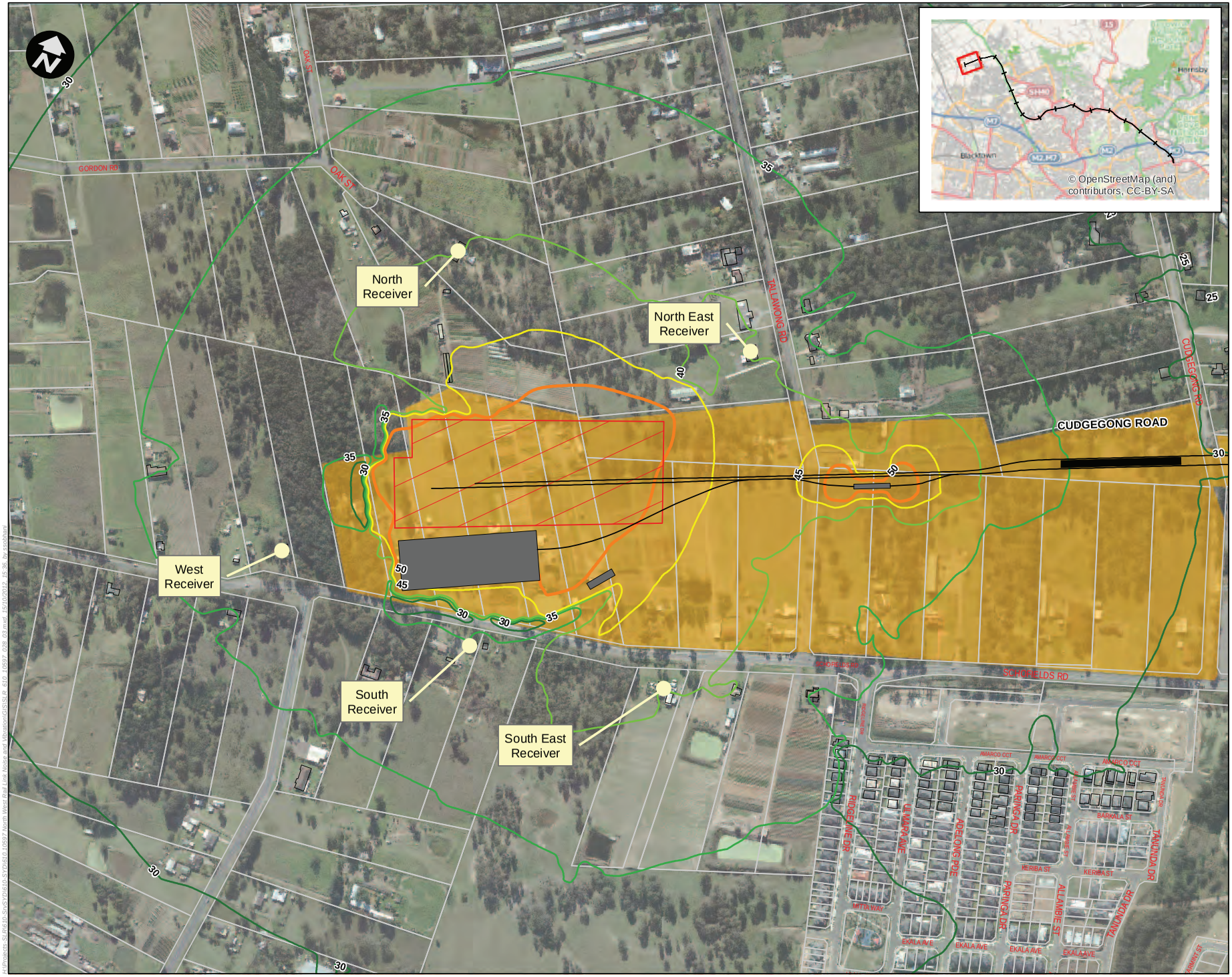
Scenario 2

Stabling and Maintenance Facility Operational Noise – At-Opening – Worst Case $L_{Aeq(15minute)}$ – Daytime Period



LEGEND

- Modelled Building Outline
- Maintenance Facility Buildings
- NWRL Acquired Land
- Indicative Stabling Area

$L_{Aeq(15minute)}$

- 30 dBA
- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA

0 25 50 100 150 200
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Noise contours calculated at 1.5m above ground level
3. $L_{Aeq(15minute)}$ noise criterion is 50 dBA for the daytime period
4. Digital Cadastral Database © LPMA 2012

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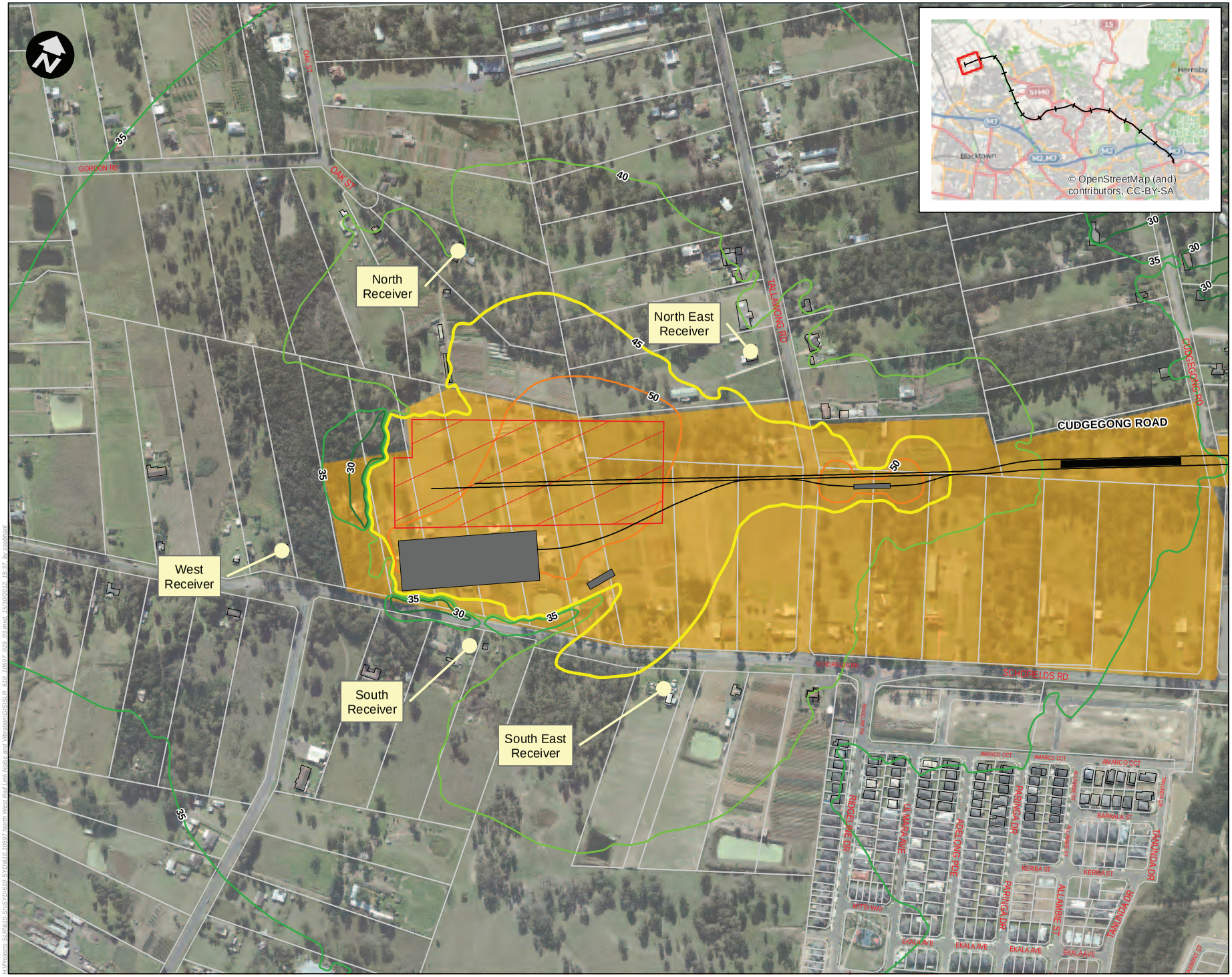
Scenario 3

Stabling and Maintenance Facility Operational Noise – At-Opening – Worst Case $L_{Aeq(15minute)}$ – Early Morning Period



LEGEND

- Modelled Building Outline
- Maintenance Facility Buildings
- NWRL Acquired Land
- Indicative Stabling Area

$L_{Aeq(15minute)}$

- 30 dBA
- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA

0 25 50 100 150 200
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Noise contours calculated at 1.5m above ground level
3. $L_{Aeq(15minute)}$ noise criterion is 45 dBA for the early morning period
4. Digital Cadastral Database © LPMA 2012
5. Noise contours calculated with adverse meteorological conditions

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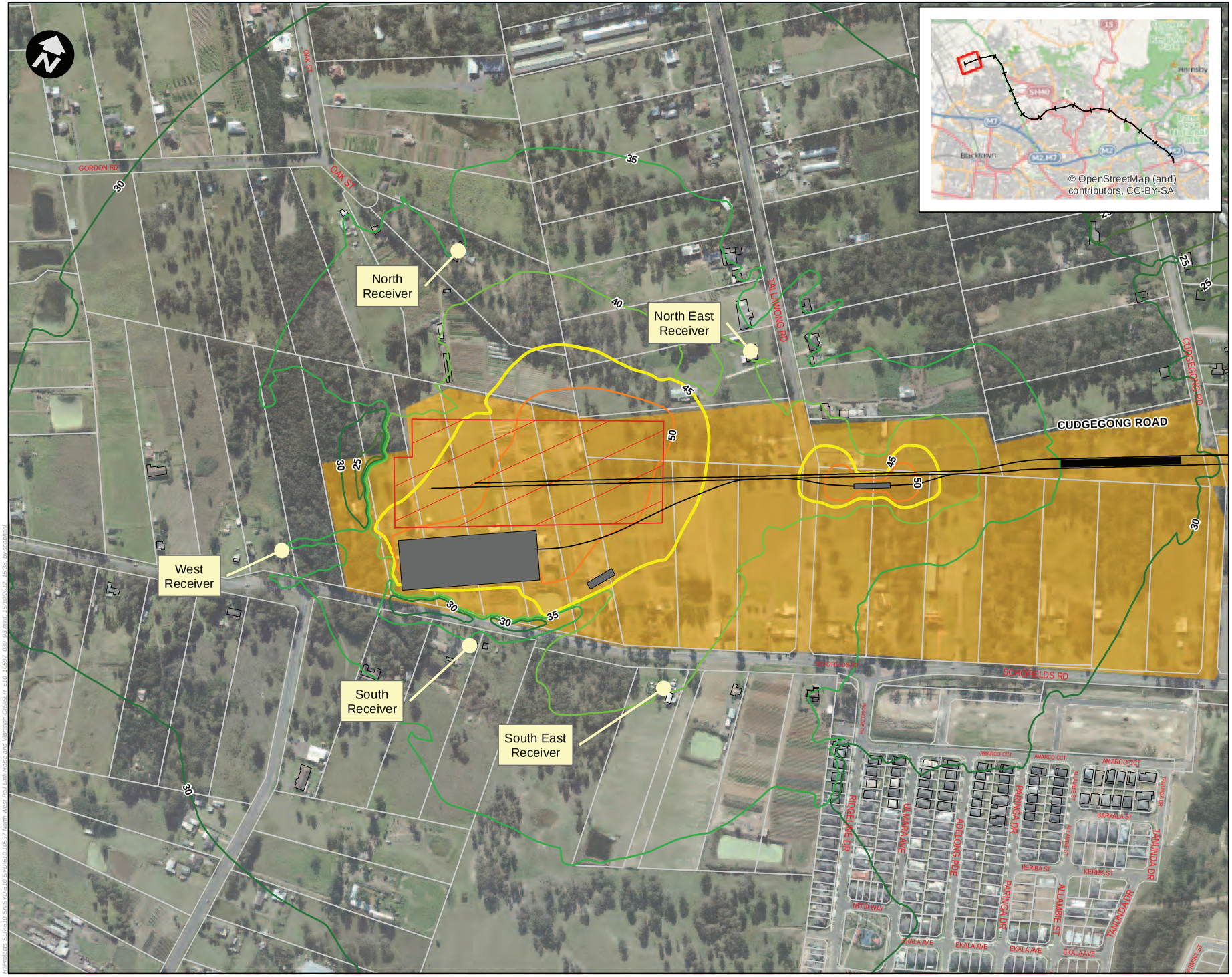
Scenario 4

Stabling and Maintenance Facility Operational Noise – At-Opening – Worst Case $L_{Aeq(15minute)}$ – Evening Period



LEGEND

- Modelled Building Outline
- Maintenance Facility Buildings
- NWRL Acquired Land
- Indicative Stabling Area

$L_{Aeq(15minute)}$

- 25 dBA
- 30 dBA
- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA

0 25 50 100 150 200
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Noise contours calculated at 1.5m above ground level
3. $L_{Aeq(15minute)}$ noise criterion is 45 dBA for the evening period
4. Digital Cadastral Database © LPMA 2012

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Scenario 5

Stabling and Maintenance Facility Operational Noise – At-Opening – Worst Case $L_{Aeq(15minute)}$ – Night-time Period

LEGEND

- Modelled Building Outline
- Maintenance Facility Buildings
- NWRL Acquired Land
- Indicative Stabling Area

$L_{Aeq(15minute)}$

- 30 dBA
- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA

0 25 50 100 150 200
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Noise contours calculated at 1.5m above ground level
3. $L_{Aeq(15minute)}$ noise criterion is 40 dBA for the night-time period
4. Digital Cadastral Database © LPMA 2012
5. Noise contours calculated with adverse meteorological conditions

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Project Name:
North West Rail Link
Noise and Vibration

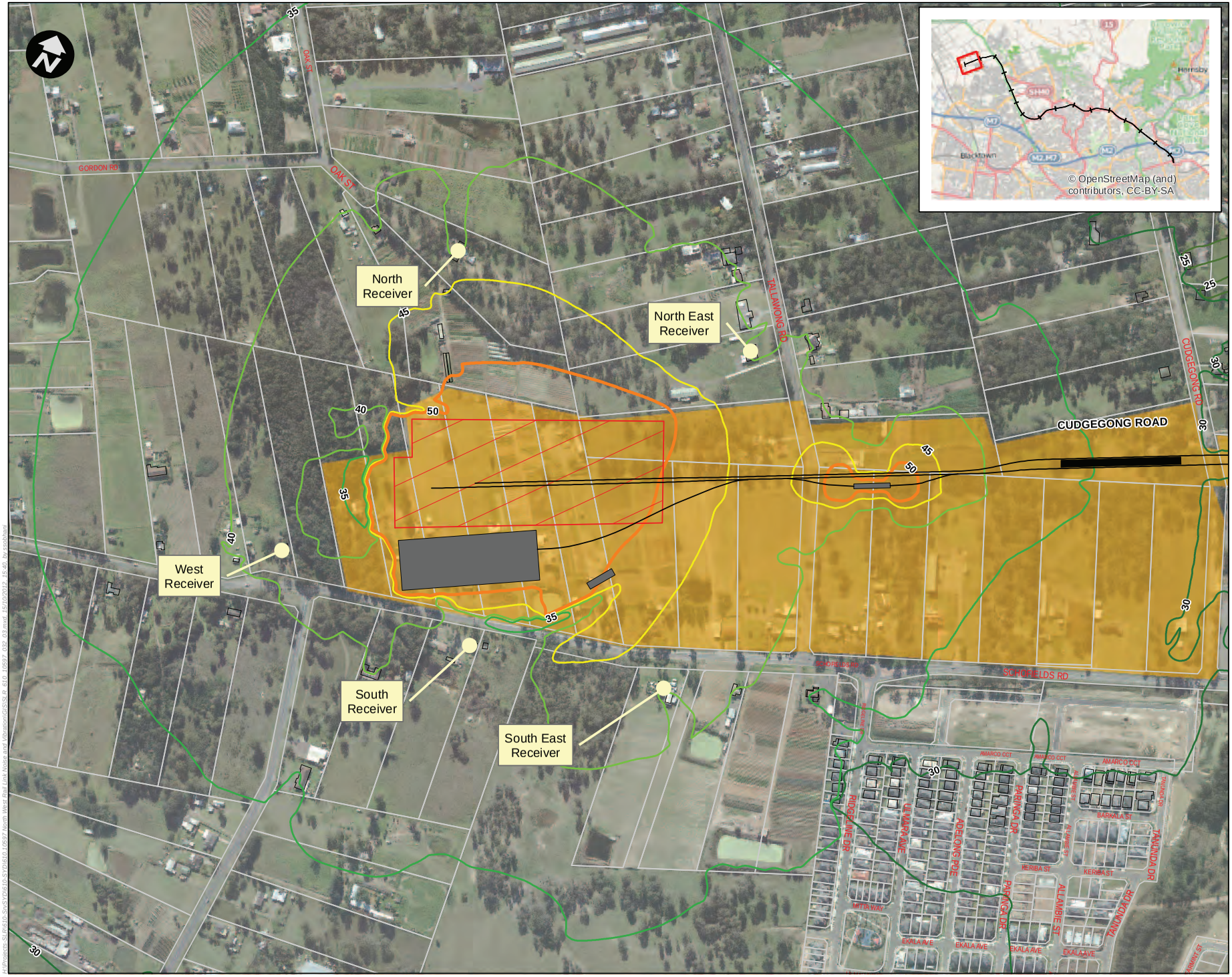
Prepared for:
Transport for NSW

Project No: **610.10597**

Scale	Date
1:5,000 @ A3	15-Oct-2012
Version: 05	Approved: Briony Croft

Scenario 6

Stabling and Maintenance Facility Operational Noise – Future Capacity – Worst Case $L_{Aeq(15minute)}$ – Daytime Period



LEGEND

- Modelled Building Outline
- Maintenance Facility Buildings
- NWRL Acquired Land
- Indicative Stabling Area

$L_{Aeq(15minute)}$

- 25 dBA
- 30 dBA
- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA

0 25 50 100 150 200
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Noise contours calculated at 1.5m above ground level
3. $L_{Aeq(15minute)}$ noise criterion is 50 dBA for the daytime period
4. Digital Cadastral Database © LPMA 2012

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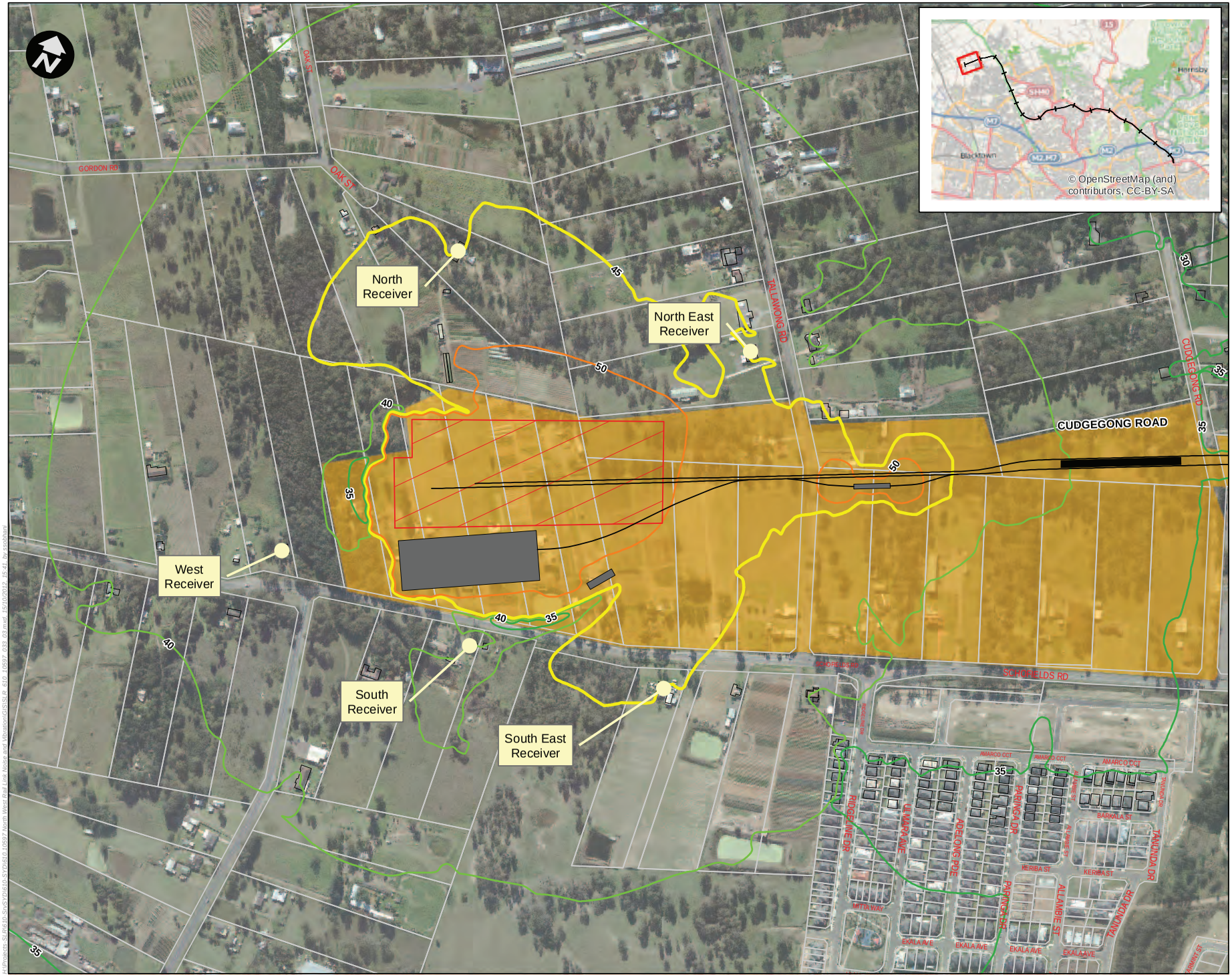
Scenario 7 — Stabling and Maintenance Facility Operational Noise – Future Capacity – Worst Case $L_{Aeq(15minute)}$ – Early Morning Period



LEGEND

- Modelled Building Outline
- Maintenance Facility Buildings
- NWRL Acquired Land
- Indicative Stabling Area

$L_{Aeq(15minute)}$

- 30 dBA
- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA

0 25 50 100 150 200
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Noise contours calculated at 1.5m above ground level
3. $L_{Aeq(15minute)}$ noise criterion is 45 dBA for the early morning period
4. Digital Cadastral Database © LPMA 2012
5. Noise contours calculated with adverse meteorological conditions

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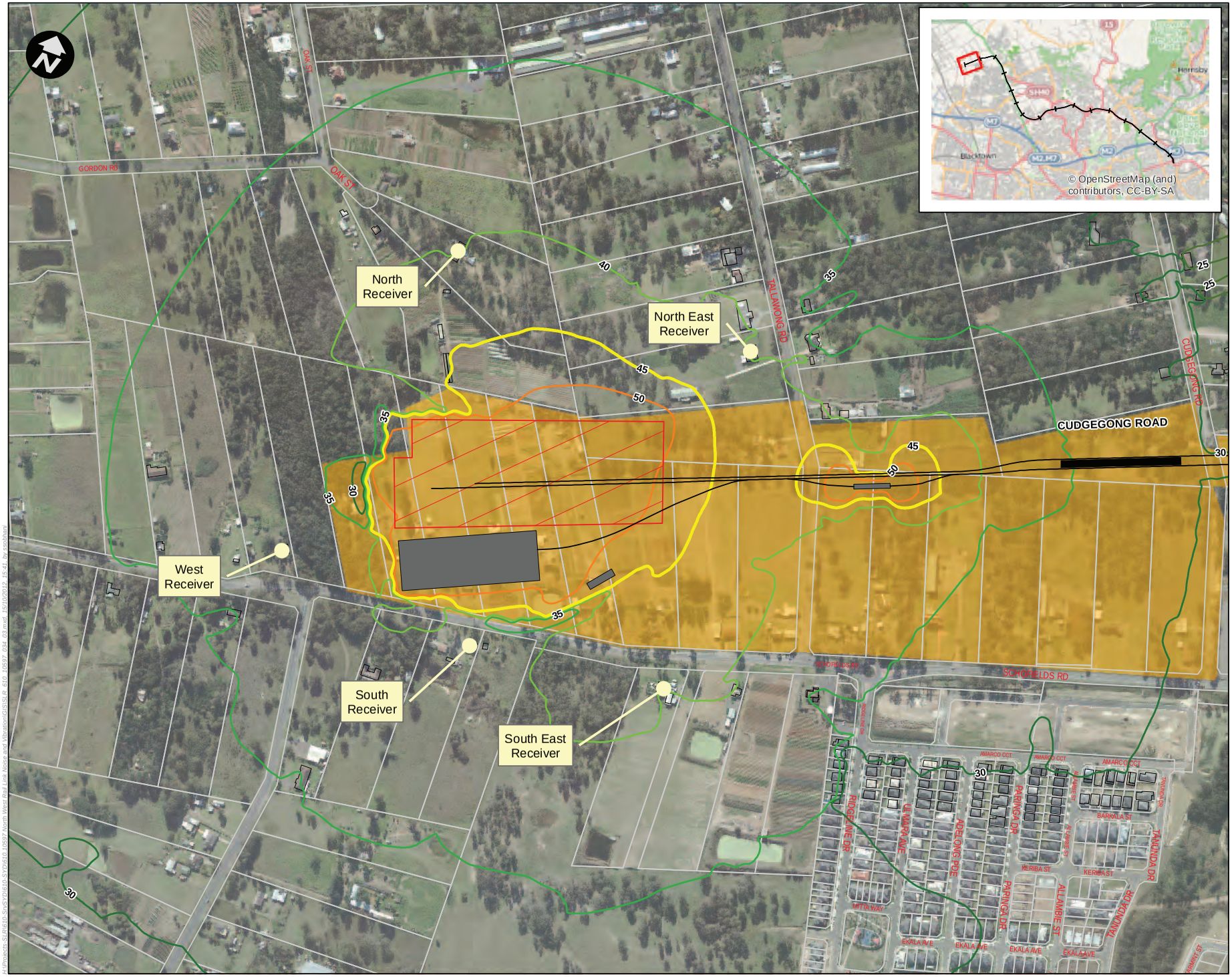
Scenario 8

Stabling and Maintenance Facility Operational Noise – Future Capacity – Worst Case $L_{Aeq(15minute)}$ – Evening Period



LEGEND

- Modelled Building Outline
- Maintenance Facility Buildings
- NWRL Acquired Land
- Indicative Stabling Area

$L_{Aeq(15minute)}$

- 25 dBA
- 30 dBA
- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA

0 25 50 100 150 200
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Noise contours calculated at 1.5m above ground level
3. $L_{Aeq(15minute)}$ noise criterion is 45 dBA for the evening period
4. Digital Cadastral Database © LPMA 2012

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Scenario 9

Stabling and Maintenance Facility Operational Noise – Future Capacity – Worst Case $L_{Aeq(15minute)}$ – Night-time Period

LEGEND

- Modelled Building Outline
- Maintenance Facility Buildings
- NWRL Acquired Land
- Indicative Stabling Area

$L_{Aeq(15minute)}$

- 30 dBA
- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA

0 25 50 100 150 200
Metres

NOTES

1. Aerial photography © Transport for NSW
2. Noise contours calculated at 1.5m above ground level
3. $L_{Aeq(15minute)}$ noise criterion is 40 dBA for the night-time period
4. Digital Cadastral Database © LPMA 2012
5. Noise contours calculated with adverse meteorological conditions

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Appendix I ECRL Conditions of Approval

The guideline entitled "*Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*" prepared by the Australian and New Zealand Environment and Conservation Council (ANZECC) shall be applicable with the exception of hours of blasting which shall be in accordance with Condition 63.

63. Blasting shall only be undertaken between the hours of 10:00 am and 3:00 pm (Monday to Friday) and 10:00 am to 1:00 pm on Saturdays and at no time on Sundays or Public Holidays, unless otherwise agreed by the EPA through the Construction Noise and Vibration Management Sub Plan Process.

64. Production blasts shall be limited to one single detonation in any one area potentially affecting residents on any one day, unless otherwise agreed by the EPA through the Construction Noise and Vibration Management Sub Plan Process.

65. For any section of the tunnel construction where blasting is proposed, a series of initial trials at reduced scale must be conducted prior to production blasting to determine site-specific blast response characteristics and to define allowable blast sizes to meet ANZECC guidelines.

Vibration Criteria

66. Vibration (other than from blasting) resulting from construction of the project shall be limited to:

    (a) For structural damage vibration - German Standard DIN 4150 and BS 7385: Part 2 – 1993; and,
    (b) For human exposure to vibration - the evaluation criteria presented in British Standard BS6472 for low probability of adverse comment unless as otherwise agreed by the Director General in consultation with EPA through the construction noise and vibration management sub plan.

67. Unless otherwise agreed by the Director-General, following consultation with the EPA, vibration levels shall not exceed 3 mm/s at heritage buildings and sensitive structures.

68. Vibration testing of actual equipment such as vibratory compactors and rock breakers shall be carried out on site to determine acceptable buffer distances to commercial and residential occupancies. The methods for testing and buffer zones shall be detailed in the Noise and Vibration Construction Management Sub Plan. Should it be necessary to use vibratory compactors or rock breakers within the buffer zone, building condition surveys of all buildings and structures within this area shall be undertaken before and after use of this type of equipment.

Operation Stage Noise

Operational Noise and Vibration Management Sub Plan

69. Prior to operation, a detailed Operational Noise and Vibration Management Sub Plan (ONVMP) shall be identified in the Operational EMP and be prepared to the satisfaction of the Director-General. The Sub 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. Details of Sub-Plan are provided in Attachment 13.

Operational Airborne Noise

70. The sound pressure level due to airborne noise emissions from train traffic on upgraded existing lines and project new lines when measured at 1 metre from the facade of a residential building, or if vacant, at any residential boundary (existing, zoned or proposed to be zoned for residential development at the time of this approval) or any other noise sensitive premises shall, where reasonable and feasible, be designed to meet the design goals identified below, unless otherwise agreed by the Director-General and the EPA through the Operational Noise and Vibration Management Planning process:

    (a) $L_{Aeq,\ 24hr}$ 55 dB(A);and,
    (b) L_{Amax} 80 dB(A).

    For the purposes of this condition:

    (i) $L_{Aeq,\ 24hr}$ is the 'A' weighted equivalent sound pressure level based on a period of 24 hours and the level indicated above should not be exceeded in any 24 hour period; and,
    (ii) L_{Amax} is the 'A' weighted maximum sound pressure level.
    (iii) Noise measurements for compliance with this condition shall be taken using the "Fast" time response.

    Where it is not reasonable and feasible to meet the above design goals, the Proponent must demonstrate as part of the Operational Noise and Vibration Management Plan that reasonable and feasible mitigation measures have been implemented or that the proposed mitigation measures are based on the outcomes of a community consultation process as identified in the ONVMP to the satisfaction of the Director-General and the EPA.

    Note: This condition only applies to the sections of track where physical upgrading works have been undertaken directly as part of this project.

71. Noise from stations (excluding patron noise but including noise from PA systems), station ventilation systems and noise from other fixed facilities including emergency access shafts (except during emergencies), ventilation systems, electrical sub-stations, electrical sectioning huts and signal huts shall be designed to meet:

    - the guidelines specified in the NSW *Industrial Noise Policy;* and,
    - $L_{A1(1\ minute)}$ levels of not more than 15dB(A) above the background level at any potentially affected noise sensitive receiver for the night time period from 10pm to 7am.

Operational Regenerated Noise

72. In addition to the requirements of Condition 76, the Proponent shall ensure the use of all reasonable and feasible measures to achieve a regenerated noise level of not exceeding $L_{A\ max}$ 20dB(A) (fast meter response) for 95% of train passby events for recording studios (including Global Studios, Film Australia and the Australian Film and Television School).

Operational Compliance Limits For Vibration and Regenerated Noise

73. For human exposure to vibration within buildings, vibration resulting from train pass-by events within the excavated tunnel shall be limited to the evaluation criteria presented in British Standard

BS 6472 for low probability of adverse comment, unless otherwise agreed by the EPA through the Operational Noise and Vibration Management Plan.

74. At least 50 percent of train passby events within the excavated tunnel over any 24-hour period shall not exceed a regenerated noise level $L_{A\ max}$ 30dB(A) (fast meter response) and at least 95 percent of train pass by events within the excavated tunnel over any 24-hour period shall not exceed a regenerated noise level $L_{A\ max}$ 35dB(A) (fast meter response) as measured in any habitable room within any residential building or nursing home.

75. In addition to the requirements of Condition 74, the Proponent shall, unless otherwise agreed by the Director-General:

(1) install a standard of direct track fixation system at least equivalent to or better than the specifications for "Direct Fix B" as set out in Table 10.7.1 of the August 2001 Technical Report A6(i) – Operational Noise and Vibration for residential areas where levels of regenerated noise, as shown in Column 6 in Appendix D of the Director-General's Report, are predicted to be at or exceed an $L_{A\ max}$ 34dB(A) (fast meter response) for 5% of train pass-by events over any 24 hour period.

(2) install a floating slab track system at least equivalent to or better than the specifications of "Floating Slab – A" as set out in Table 10.7.1 of the August 2001 Technical Report A6(i) – Operational Noise and Vibration for all residential areas where:

(i) the standard of direct fixation system indicated in Column 5 in Appendix D of the Director-General's Report is already at Direct Fix B or better as specified in (1) above; and,
(ii) levels of regenerated noise as shown in Column 6 of Appendix D of the Director-General's Report are predicted to be at or exceed an $L_{A\ max}$ 34dB(A) (fast meter response) for 5% of train pass-by events over any 24 hour period.

If any amendments are made to the alignment (horizontal or vertical) on which Appendix D was based (ie Reference Alignment 4) resulting in any changes to chainages, and/or predicted noise levels, the Proponent shall consult with the Director-General and the EPA prior to finalising the location of the mitigation measures identified in (1) and (2) to ensure that the intent of this condition is still met.

Nothing in this Condition shall be interpreted as limiting the requirements specified in Condition 74.

76. For particular sensitive receptors such as Global Studios, Australian Film, Television and Radio School, Film Australia and other recording studios at least 95% of train passby events within the tunnel shall not exceed a criteria of $L_{A\ max}$ 25dB(A) (fast meter response) as measured in any sensitive studio(s) space.

Should complaints be received from any of the sensitive receptors with respect to significant impacts on the operation of the business as a direct result of the regenerated noise impacts of the operation of the Project, an independent investigation(s) shall be undertaken including noise and/or vibration monitoring capable of providing spectral data at least over the range 16 to 1000Hz and an assessment of the reasonable noise and vibration requirements of the business. Should the investigations/monitoring indicate reasonable affectation of the business as a direct result of the noise and/or vibration generated by the Project, appropriate measures shall be undertaken that are reasonable and feasible to mitigate the concerns of the business(s). Should a dispute arise with respect to the proposed mitigation measures, the dispute shall be referred to the Director-

General for resolution. The Director-General may refer the matter to an Independent Review Panel, which shall be established by the Proponent in consultation with the EPA. The Director-General shall appoint the Panel composition and chair. All costs incurred in establishing and implementing the Panel shall be borne by the Proponent.

76A. Regenerated noise from train movements at CTI when measured in any habitable room or other noise sensitive premises shall not exceed LAmax 40dB(A) (fast meter response) for 95 % of train pass by events over a 24 hour period.

Prior to construction, a Noise Report, prepared by an independent qualified acoustic consultant, shall be submitted by the Proponent for approval of the DG demonstrating how, in the final design of the CTI, the Proponent has endeavoured to reduce the maximum regenerated noise level below the above referred maximum level of 40dB(A). The Report shall detail the proposed mitigation/treatment measures and the regenerated noise level predictions.

Other Operational Noise Controls

77. Within 24 months of this approval (or as otherwise agreed by the Director-General), the Proponent shall in consultation with the EPA assess the likely impacts of wheel defects on regenerated noise through a Study of at least one existing rail tunnel. Should this Study indicate the reasonable potential for wheel defects:

(a) resulting in regenerated noise levels of above $L_{A\ max}$ 35 dB(A) (fast meter response) as measured in any habitable room within any residential building or nursing home from train passby events within the excavated Parramatta Rail Link tunnel; and,

(b) such defects would otherwise not be removed from service in accordance with the SRA's Wheel Manual TRS 0163.06,

then the Proponent shall, prior to operation, establish a High Noise Train Event Management Strategy as part of the Operational Noise and Vibration Management Plan.

The Strategy shall include but not be limited to:

(i) identification of trains or carriages that are likely to cause regenerated noise levels within any habitable room in any residential building or nursing home of more than an LAmax level of 35 dB(A) (fast meter response);

(ii) the timeframes and actions that will apply to the trains or carriages identified in (i);and,

(iii) how any complaints (if any) which can be linked to the trains/carriages identified in (i) will be addressed.

In preparing the report, the Proponent shall give due consideration to the suitability of automated wheel condition monitoring systems

In the event that the assessment indicates that wheel defects are not likely to impact on regenerated noise levels causing exceedances above 35dB(A), an alternative High Noise Train Event Management Strategy shall be prepared to address the issues in (i), (ii) and (iii) above, and incorporated in the Operational Noise and Vibration Management Plan.

78. In addition to the requirements of Conditions 74, the 5% exceedance re-generated noise levels (for any habitable room) that may be interpolated from the August 2001 Technical Report A6(i) to be 28dB(A) or greater, shall not be permitted to be exceeded by a margin more than 3 dB(A).

Operational Noise Management

79. As part of the ONVMP, process for responding to the potential for complaints about regenerated noise impacts shall be established. If complaints are received from areas where there is a reasonable potential for localised regenerated noise impacts, an independent investigation(s), including monitoring (subject to complainant agreement) of regenerated noise, shall be undertaken. Should monitoring indicate localised exceedance of the limits specified in Condition 74 the Proponent shall implement reasonable and feasible measures to meet the limits and/or mitigate the concerns of the resident(s).

80. A detailed impact assessment report on operational airborne and regenerated noise and vibration shall be undertaken in accordance with the Operational Noise Management Sub Plan after two and seven years from the opening the project and at any other time as required by the Director-General. The Report shall have regard to compliance with the criteria specified in Conditions, 70, 71,73, 74, and 76 and specific areas to be identified in consultation with the EPA. Should assessment indicate a clear trend for noise and/or vibration levels to exceed the criteria established under the ONVMP, the Proponent shall implement further reasonable and feasible mitigation measures in consultation with affected landowners and/or occupiers.

81. Should the results of the monitoring show that any of the criteria specified in Conditions 74 or 76 have been exceeded, the Proponent shall submit a report prepared by an independent person/organisation to the Director-General on the cause and major contributor to the exceedance and the options available to ensure prevention of a recurrence. This consideration must include the option of retrofitting mitigation treatments. If the Report does not recommend retrofitting of noise treatment then this recommendation must be clearly justified. The Proponent shall comply with the reasonable requirements of the Director-General following the review of this report. This report shall be made publicly available.

Spoil Management

82. As part of the formal tender evaluation process, the Proponent shall demonstrate to the satisfaction of the Director-General that the externality costs of truck-based removal of spoil as been explicitly considered in the comparative ranking and rating of tenders on the issue of cost. For the purposes of quantifying and comparing externality costs under this condition, the Proponent shall submit for approval of the Director-General a schedule of assessment truck levies (in 2001 dollars) for at least the following:

    (a) local roads;
    (b) (b regional roads;
    (c) state roads with the exception of Freeways or Tollways; and,
    (d) No levy for Freeways or Tollways.

    The Proponent shall provide details of how the assessment levies have been determined and shall provide a preliminary estimate of the total levy charge for the project.

    The assessment levy shall take into account the timeframe for construction and adjusted in accordance with historic CPI trends, and applied to each proposed year of truck movements.

Appendix J Construction Noise and Vibration Strategy

North West Rail Link

Construction Noise and Vibration Strategy

Date:	**February 2012**
Author:	SLR Consulting
Revision:	NWRL-10046-R-NO-00004-v1.0-Construction NO Str.docx
Status:	Final
	None

Document Control

Document	North West Rail Link Construction Noise and Vibration Strategy
Ref Number	NWRL-10046-R-NO-00004v1.0-Construction NO Str
Date	16 February 2012
Prepared by	Conrad Weber
Checked by	John Sleeman
Authorised by	Conrad Weber

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
1.0	16/2/2012	Final	Conrad Weber / Project Manager	

Prepared for:

Transport for NSW

Prepared by:

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2 Lincoln St LANE COVE NSW 2066, Australia

Contents

Glossary

Item	Description / Definition
AMMM	Additional Mitigation Measures Matrix
AS	Australian Standard
BS	British Standard
CNVIS	Construction Noise and Vibration Impact Statement
CNVMP	Construction Noise and Vibration Management Plan
CNVS	Construction Noise and Vibration Strategy
DEC	Department of Environment and Conservation NSW – Now OEH
DECC	Department of Environment and Climate Change NSW – Now OEH
DECCW	Department of Environment, Climate Change and Water NSW – Now OEH
EIS	Environmental Impact Statement
EMR	Environmental Management Representative
EPA	Environment Protection Authority – Now OEH
EPL	Environment Protection Licence
ICNG	Interim Construction Noise Guideline
NWRL	North West Rail Link
OEH	Office of Environment and Heritage
OOHW	Out of Hours Work
RBL	Rating Background Level
REF	Review of Environmental Factors
RMS	Root Mean Square
SLR Consulting	SLR Consulting Australia Pty Ltd
SPL	Sound Pressure Level
SWL	Sound Power Level
TBM	Tunnel Boring Machine
TCA	Transport Construction Authority

1 Introduction

1.1 Purpose and Scope

The purpose of this document is to provide practical guidance on how to minimise, to the fullest extent practicable, the impacts on the community from airborne noise, ground-borne noise and vibration generated during the construction of the North West Rail Link (NWRL) project through the application of all feasible and reasonable mitigation measures.

This version of the Construction Noise and Vibration Strategy (CNVS) may be subject to change to reflect the outcomes of the planning approvals process, including Conditions of Approval relating to site-specific mitigation measures.

In addition to the mitigation measures described in this strategy, contractors may introduce further measures or mitigation strategies to reduce noise and vibration impacts at sensitive receivers.

1.2 Definitions

All terminology in this Construction Noise and Vibration Strategy (CNVS) is taken to mean the generally accepted or dictionary definition with the exception of the following terms which have a specifically defined meaning:

L_{Amax}	The “Maximum Noise Level” for an event, used in the assessment of potential sleep disturbance during night-time periods. The subscript “A” indicates that the noise levels are filtered to match normal human hearing characteristics (ie A-weighted).
$L_{Aeq(15minute)}$	The “Energy Average Noise Level” during construction activities, evaluated over a measurement period of 15 minutes. This is the main parameter used to assess the construction noise impacts.
L_{A90}	The “Background Noise Level” in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The $L_{Aeq(15minute)}$ construction noise objectives are based on an allowance margin above the L_{A90} background noise levels.
PPV	“Peak Particle Velocity” evaluated at the building footings and used to assess the risk of damage to structures.
Arms	“Root mean squared weighted acceleration”, a vibration parameter used to assess human response to continuous or intermittent vibration.
VDV	“Vibration Dose Value”, the overall vibration exposure assessed over the daytime or night-time period to assess human response to intermittent vibration.

1.3 Overview

The construction noise and vibration emissions associated with a large infrastructure project such as NWRL can cause disturbance to adjacent communities.

For some of the proposed construction works, activities will be required outside normal construction hours because work during daytime periods would be highly disruptive to commuter services and road traffic on major roads. The NWRL proposal includes approximately 15 km of twin underground tunnels which are likely to be constructed using tunnel boring machines (TBMs) and road headers. Additional supporting plant and activities would be required at some sites on a 24 hour per day basis to meet program requirements and facilitate the efficient operations of the tunnelling works. In addition to site-specific mitigation measures, the community should be consulted about the potential impacts, the time periods over which these will occur and the proposed mitigation measures.

This CNVS is based on the Transport Construction Authority (TCA) *"Construction Noise Strategy"*, updated to address the specific requirements of NWRL and recent changes in noise and vibration standards.

The CNVS has been developed to address the assessment requirements documented in DECC's *"Interim Construction Noise Guideline"* (ICNG). The main focus of the interim guideline is to minimise construction noise and vibration impacts, rather than focus only on achieving numeric noise levels, and recognises that some noise and vibration from construction sites is inevitable. The interim guideline encourages organisations involved with construction, maintenance or upgrading works to develop their own best-practice techniques for managing construction noise and vibration, and implementing feasible and reasonable mitigation measures. This CNVS is consistent with this recommendation.

In preparing this document, consideration has also been given to guidance contained in Australian Standard AS 2436-2010 – *"Guide to noise and vibration control on construction, demolition and maintenance sites"*.

The key elements of the CNVS involve:

- evaluating the construction noise and vibration impacts during the environmental impact assessment stage of a project to identify, in consultation with the community and other stakeholders, project specific construction noise and vibration objectives and possible mitigation measures for them
- implementing a standard suite of noise and vibration mitigation measures across all construction sites
- implementing additional mitigation measures when construction noise or vibration is predicted to exceed the project's construction noise and vibration objectives
- verifying the validity of noise assessments undertaken during the environmental impact assessment stage prior to construction commencing to ensure that any changes to the project's design, scope, construction method or the mitigation measures proposed in the environmental impact assessment are re-evaluated and any additional (or changes to the) mitigation measures are identified
- monitoring the implementation and effectiveness of the project's noise and vibration mitigation measures via a three monthly audit cycle.

1.4 Distribution and Use

This document may be used in the development of, or referred to in:

- environmental impact assessment documents
- design and construction environmental management documents
- contract documents
- approvals and licences (subject to the agreement of the relevant regulatory authority).

This document does not take precedence over approval or licence conditions and will be reviewed as required in response to the release of relevant guidelines, standards and policies dealing with construction noise and vibration.

2 Assessing the Impacts of Construction Noise and Vibration

As part of the environmental impact assessment process, the impacts on nearby receivers of airborne noise, ground-borne noise and ground-borne vibration generated during the construction of the NWRL project are evaluated. This assessment shall be undertaken by an acoustic consultant and shall form part of the environmental impact assessment documentation (eg. REF or EIS) that is considered by the approval authorities. The noise and vibration construction assessment:

- is based on an initial design, scope and construction methodology for the project
- identifies sensitive receivers, the existing background noise levels and, in accordance with guidelines administered by the Office of Environment and Heritage (OEH) (see Appendix A), the construction noise and vibration objectives
- provides guidance in relation to project specific feasible and reasonable noise and vibration mitigation measures[1] that are needed to meet or mitigate any predicted exceedances of the construction noise and vibration objectives at the nearest receivers.

In most cases, a noise and vibration assessment is included in the documentation placed on public display (eg EIS or REF). Comments received from the community and other stakeholders on the proposed mitigation measures for the project are considered and, if necessary, changes may be made to the measures proposed, or additional measures included, prior to the project being approved or licensed. Appendix A describes in detail the construction noise and vibration assessment process.

The construction noise and vibration objectives for the project and any accompanying mitigation measures in the environmental impact assessment documentation are based on an initial design and construction methodology. Typically, as the design of a project is further developed following its approval, the construction methodology and staging is also altered.

To ensure the adequacy of the noise and vibration mitigation measures for the actual design and construction method, a Construction Noise and Vibration Impact Statement (CNVIS) must be prepared (for each major construction site and/or stage or key activity), prior to the preparation of the Construction Noise and Vibration Management Plan (CNVMP) for that stage/activity. This process is outlined in Figure 2.1. The CNVIS must be prepared in accordance with the requirements of Appendix B. The CNVIS should be used as the basis on which to develop the CNVMP[2] for the project. A separate CNVIS must be prepared for each major stage of works or activity and the CNVMP revised as required.

[1] For example: physical structures such as construction hoardings, acoustic sheds, dwelling treatments, acoustic barriers around noisy plant, operational noise barriers erected early etc or special construction methods such as penetrating cone fracture or controlled blasting in place of conventional rock breaking, etc.

[2] NB: Any changes to the project must be consistent with the environmental assessment documentation and project approval and cannot cause significant additional impacts on the environment or community.

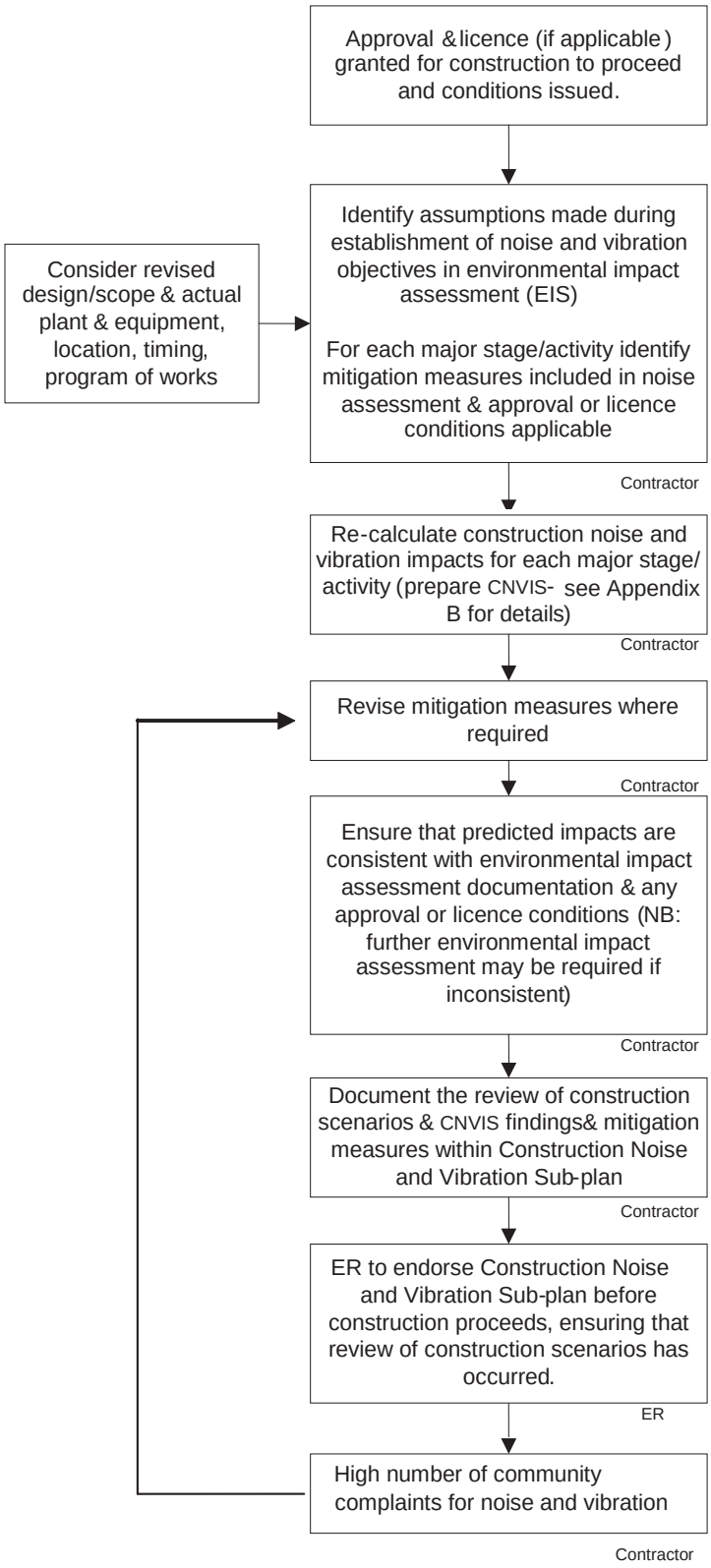

Figure 2.1 Construction Noise and Vibration Assessment Review Procedure

3 Standard Mitigation Measures and Monitoring Requirements

This section sets out the *standard* construction noise and vibration mitigation measures to be implemented on the NWRL project and delivered via relevant procedures, systems, environmental impact assessment, construction environmental management and all relevant contract documentation.

For all NWRL construction activities, the standard mitigation measures in Table 3.1 shall be applied in order to minimise the potential noise and vibration impacts at the nearest receptors. Additional information in relation to specific mitigation measures, the assessment process and relevant objectives are provided in the Appendices.

During the preparation of the environmental impact assessment documentation, a construction noise and vibration assessment is to be undertaken. This includes monitoring requirements in order to validate the modelling assumptions and confirm that noise and vibration levels from individual plant and equipment items are not excessive. This section provides guidance in relation to standard monitoring and survey requirements that are expected for the NWRL project.

Additional information is also provided in this section in relation to satisfactory operating distances to ensure that vibration levels are not excessive at nearby buildings in relation to cosmetic damage and human comfort.

3.1 Standard Mitigation Measures

The actions set out in Table 3.1 must be implemented on all NWRL construction sites.

Table 3.1 Standard Mitigation Measures to Reduce Construction Noise and Vibration

Action Required	Applies to	Details
Management Measures		
Implementation of any project specific mitigation measures required	Airborne noise Ground-borne noise and vibration	In addition to the measures set out in this table, any *project specific* mitigation measures identified in the environmental assessment documentation (e.g. EIS, REF, submissions or representations report) or approval or licence conditions must be implemented.

Action Required	Applies to	Details
Implement community consultation measures (refer to Appendix C for further details of each measure)	Airborne noise Ground-borne noise and vibration	Periodic notification (monthly letterbox drop or equivalent)[3] Website Project Infoline Construction Response Line Email Distribution List Community Based Forums (if required by approval conditions) One-on-one meetings with properties most affected by noise and vibration Prior notification of disruptive work that will generate noise/vibration in excess of guidelines or night works
Site inductions	Airborne noise Ground-borne noise and vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: all relevant project specific and standard noise and vibration mitigation measures relevant licence and approval conditions permissible hours of work any limitations on high noise generating activities location of nearest sensitive receivers construction employee parking areas designated loading/unloading areas and procedures site opening/closing times (including deliveries) environmental incident procedures
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Monitoring	Airborne noise Ground-borne noise and vibration	A noise monitoring program is to be carried out for the duration of the works in accordance with the CNVMP and any approval and licence conditions.

[3] Detailing all upcoming construction activities at least 14 days prior to commencement of relevant works

Action Required	Applies to	Details
Attended vibration measurements	Ground-borne vibration	Attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Source Controls		
Construction hours and scheduling	Airborne noise Ground-borne noise and vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods, nominally between 8 am and 5 pm with no work on Sundays or public holidays.
Construction respite period	Airborne noise Ground-borne noise and vibration	High noise and vibration generating activities[4] may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block[5]. No more than four consecutive nights of high noise and/or vibration generating work may be undertaken over any seven day period, unless otherwise approved by the relevant authority.
Equipment selection	Airborne noise Ground-borne noise and vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits.
Maximum noise levels	Airborne noise	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Table 3.2.
Rental plant and equipment	Airborne noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 3.2.

[4] Includes jack and rock hammering, sheet and pile driving, rock breaking and vibratory rolling.

[5] "Continuous" includes any period during which there is less than a 60 minutes respite between ceasing and recommencing any of the work.

Action Required	Applies to	Details
Use and siting of plant	Airborne noise	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers.
Plan worksites and activities to minimise noise and vibration	Airborne noise Ground-borne noise and vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work (refer Table 7 and Appendix C of ICNG).
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.
Path Controls		
Shield stationary noise sources such as pumps, compressors, fans etc.	Airborne noise	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix D of AS 2436:2010 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

3.2 Noise and Vibration Auditing

The implementation of the noise and vibration mitigation measures, compliance with any applicable construction noise and vibration objectives, monitoring requirements and approval and licence conditions is to be audited at least every three months. This will involve the measurement of equipment noise levels (on site) and noise and vibration monitoring at the nearest sensitive receivers. A summary of the measurement requirements is provided below and in Appendix A.

The attended measurements will need to be carried out by an appropriately trained person in the measurement and assessment of construction noise and vibration, who is familiar with the requirements of the relevant standards and procedures.

Maximum levels for plant and equipment

All plant and equipment used for construction must have operating Sound Power or Sound Pressure Levels less than or equal to those in Table 3.2. For construction equipment not listed in Table 3.2, reference should be made to the typical noise levels in AS 2436-2010, BS 5228-1 or DEFRA noise database.

The maximum noise levels in Table 3.2 can also be used as a guide in the prediction of $L_{Aeq(15minute)}$ construction noise. In doing so, the predicted $L_{Aeq(15minute)}$ noise levels will be dependent on several factors including, but not limited to the duration of the construction activities, the number of plant items and their location on site in relation to the nearest receivers.

Attended measurements are to be undertaken within a period of 14 days of equipment arriving on site to confirm that the operating noise levels of all plant items comply with the maximum levels in Table 3.2. The attended measurements are to be repeated on a three-monthly basis to ensure that noise from individual plant items are still within the acceptable noise range.

Table 3.2 Maximum Allowable Noise Levels for Construction Equipment

Equipment	**Maximum Allowable Noise Level (dBA) – L_{Amax} [1,2,3]**	
	Sound Power Level	**Sound Pressure Level at 7 m**
Excavator Hammer	122	97
Excavator (approx. 3 tonne)	90	65
Excavator (approx. 6 tonne)	95	70
Excavator (approx. 10 tonne)	100	75
Excavator (approx. 20 tonne)	105	80
Excavator (approx. 30 tonne)	110	85
Excavator (approx. 40 tonne)	115	90
Skidsteer Loaders (approx. 1/2 tonne)	107	82
Skidsteer Loaders (approx. 1 tonne)	110	85
Dozer (equiv. CAT D8)	118	93
Dozer (equiv. CAT D9)	120	95
Dozer (equiv. CAT D10)	121	96
Backhoe/FE Loader	111	86
Dump Truck (approx. 15 tonne)	108	83

Equipment	Maximum Allowable Noise Level (dBA) – L_{Amax} [1,2,3]	
	Sound Power Level	Sound Pressure Level at 7 m
Concrete Truck	112	87
Concrete Pump	109	84
Concrete Vibrator	105	80
Bored Piling Rig	110	85
Scraper	110	85
Grader	110	85
Vibratory Roller (approx. 10 tonne)	114	89
Vibratory Pile Driver	121	96
Impact Piling Rig	134	109
Compressor (approx. 600 CFM)	100	75
Compressor (approx. 1500 CFM)	105	80
Concrete Saw	118	93
Jackhammer	113	88
Generator	104	79
Lighting Tower	80	55
Flood Lights	90	65
Cherry Picker	102	77
Mobile Crane	110	85

Notes:

1. The Sound Power Level (SWL) represents the total noise output of the plant of equipment. The SWL is normally used in computer noise models to predict the Sound Pressure Levels (SPLs) at nearby receivers. When undertaking site compliance measurements, it is normally the SPL that is measured at a specified distance (typically 7m) from the plant or equipment.
2. The SWLs presented in the above table have been compiled from a selection of field measurements conducted by SLR Consulting (formerly Heggies Pty Ltd) between 2004 and 2006 of plant and equipment operating on construction projects throughout NSW and are therefore considered to be representative of plant and equipment SWLs which are readily achieved by current plant and equipment normally used in the construction industry.
3. Plant and equipment with SWLs higher than those presented in the table would be deemed to be emitting an excessive level of noise and should not be permitted to operate on construction sites.

Noise and vibration monitoring in the community

Attended measurements are to be undertaken within a period of 14 days from the commencement of construction activities to confirm that the noise and vibration levels in the adjacent community are consistent with the predictions in the CNVIS[6], approval and/or licence conditions.

The attended measurements must be undertaken at the potentially most exposed receivers.

Noise measurements shall be undertaken consistent with the procedures documented in AS1055.1-1997 *"Acoustics - Description and Measurement of Environmental Noise - General Procedures"*. Vibration measurements shall be undertaken in accordance with the procedures

[6] Or other relevant acoustic assessment

documented in DEC's *"Assessing Vibration - a technical guideline"* and BS7385 Part 2-1993 *"Evaluation and measurement for vibration in buildings"*.

For construction sites with a duration of greater than three months, the attended measurements are to be repeated on a three-monthly basis as part of the audit cycle to ensure that noise and vibration levels in the adjacent community remain consistent with the predicted levels in the CNVIS, approval and/or licence conditions. For construction sites with a duration of less than three months, or where out of hours works are required, the attended measurements must be undertaken at the time intervals described in the CNVIS, out of hours assessment, approval and/or licence conditions.

Attended measurements will also be undertaken in response to a large number of or sustained complaints about noise and vibration.

3.3 Ground Vibration – Safe Working Distances for Intensive Activities

As a guide, safe working distances for typical items of vibration intensive plant are listed in Table 3.3. The safe working distances are quoted for both "cosmetic" damage (refer BS 7385) and human comfort (refer DEC's *"Assessing Vibration - a technical guideline"*). The safe working distances for cosmetic damage must be complied with at all times, unless otherwise approved by the relevant authority.

Table 3.3 Recommended Safe Working Distances for Vibration Intensive Plant

Plant item	Rating/description	Indicative working distance	
		Cosmetic damage (BS7385)	Human response (DEC Vibration Guideline)
Vibratory roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg - 12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg - 18 to 34t excavator)	22 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm diameter	2 m (nominal)	N/A
Jack hammer	Hand held	1 m (nominal)	Avoid contact with structure

Note: More stringent conditions may apply to heritage or other sensitive structures

The safe working distances presented in Table 3.3 are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions. Vibration monitoring is recommended to confirm the safe working distances at specific sites.

For highly sensitive receivers (eg, high technology facilities, recording studios and cinemas), specific assessment is required to ensure satisfactory operation of the facility and determine if any mitigation or management measures are required to minimise the potential impacts.

In relation to human comfort (response), the safe working distances in Table 3.3 relate to continuous vibration. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed (see Appendix A). Where the predicted vibration levels exceed the human comfort objectives, the procedures in Section 5 are to be followed in order to mitigate the potential impacts at sensitive receivers.

3.4 Occupational Health and Safety Considerations

In addition to potential noise and vibration impacts on the community and structures, construction noise and vibration can also have an adverse impact upon the health of workers.

The main adverse impacts of hazardous noise are permanent noise-induced hearing loss and interference with clearly hearing instructions and/or audible warning signals. Excessive vibration from hand-held power tools (such as jack hammers) and whole body vibration (from mobile plant) can lead to adverse impacts such as white-finger disease, damage to tendons and nerves, and lower back pain.

For the above reasons, it is important that contractors adopt management strategies to prevent or minimise worker exposure to excessive noise and vibration. Such measures will also assist in reducing noise and vibration impacts on the surrounding community.

The series of Standards, AS/NZS 1269 Parts 0 to 4, sets out procedures to assess, control, manage and review noise hazards, and the *"National Standard for Occupational Noise"* defines the noise limits that are applicable in NSW.

The *"National Code of Practice for Prevention of Musculoskeletal Disorders from Performing Manual Tasks at Work"* contains guidance on assessing and controlling vibration risks.

4 Construction Hours

Standard Construction Hours

The *standard* construction hours are set out in the approval and licence (if applicable) conditions for each project. The recommended standard hours of construction in NSW are:

- 7.00 am to 6.00 pm Monday to Friday
- 8.00 am to 1.00 pm Saturday
- No work on Sundays and Public Holidays.

Other hours may be worked if approved by the relevant authority.

Blasting Hours

For blasting, the recommended standard hours of construction in NSW are:

- 9.00 am to 5.00 pm Monday to Friday
- 9.00 am to 1.00 pm Saturday
- No blasting on Sundays and Public Holidays.

Other hours may be worked if approved by the relevant authority.

Confining construction activities (including the delivery of plant and equipment) to the hours above wherever feasible and reasonable helps reduce noise and vibration impacts by limiting potentially noisy construction activities to the daytime, when background noise levels are higher, and by providing respite from construction noise during the evening, overnight and on weekends.

Out of Hours Work (OOHW)

The ICNG identifies five categories of works that may be required to be undertaken outside the standard construction hours:

1. The **delivery of oversized plant or structures** that police or other authorities determine require special arrangements to transport along public roads
2. **Emergency work** to avoid the loss of life or damage to property, or to prevent environmental harm
3. **Maintenance and repair of public infrastructure** where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
4. **Public infrastructure works** that shorten the length of the project and are supported by the affected community
5. Works where a proponent demonstrates and justifies **a need to operate outside the recommended standard hours**.

For the last two categories, the proponent (Transport for NSW) is required to provide the relevant authority with clear justification for the proposed OOHW. This justification should be provided as part of the environmental impact assessment process.

For NWRL, OOHW are likely to be required at several construction sites. These sites are identified in the EIS, together with clear justification why the proposed activities cannot be undertaken within the standard construction hours.

Activities requiring OOHW are likely to include works adjacent to the existing rail network at Epping, works on or near major roads, the delivery of oversize plant and structures and works associated with continuous tunnelling activities (including spoil removal via the road network). These activities are likely to form part of the environment protection licence.

During construction, additional OOHW may be required. For activities which do not form part of the project approval or licence conditions, the procedure for assessing and approving/rejecting proposals is set out in Figure 4.1. The key features of the procedure include:

- All applications for out of hours work must be made on the approved form[7] and accompanied by the required information
- Out of hours work with low or medium risk factors (see Figure 4.1) may be approved by the Environmental Management Representative (EMR) for the project
- Applications for approval of out of hours work with medium or high risk factors *(including those requiring OEH approval)* must be supported by a CNVIS or other acoustic assessment prepared in accordance with the guidance in Appendix B and relevant licence conditions
- Out of hours work with a high risk factor can only be approved by NWRL's Principal Manager, Environment or the Department of Planning and Infrastructure (DP&I) (whichever is applicable) following the endorsement of the EMR.

[7] This form is not used for applications for out of hours work covered by a licence. The licence holder will have their own procedure covering such applications.

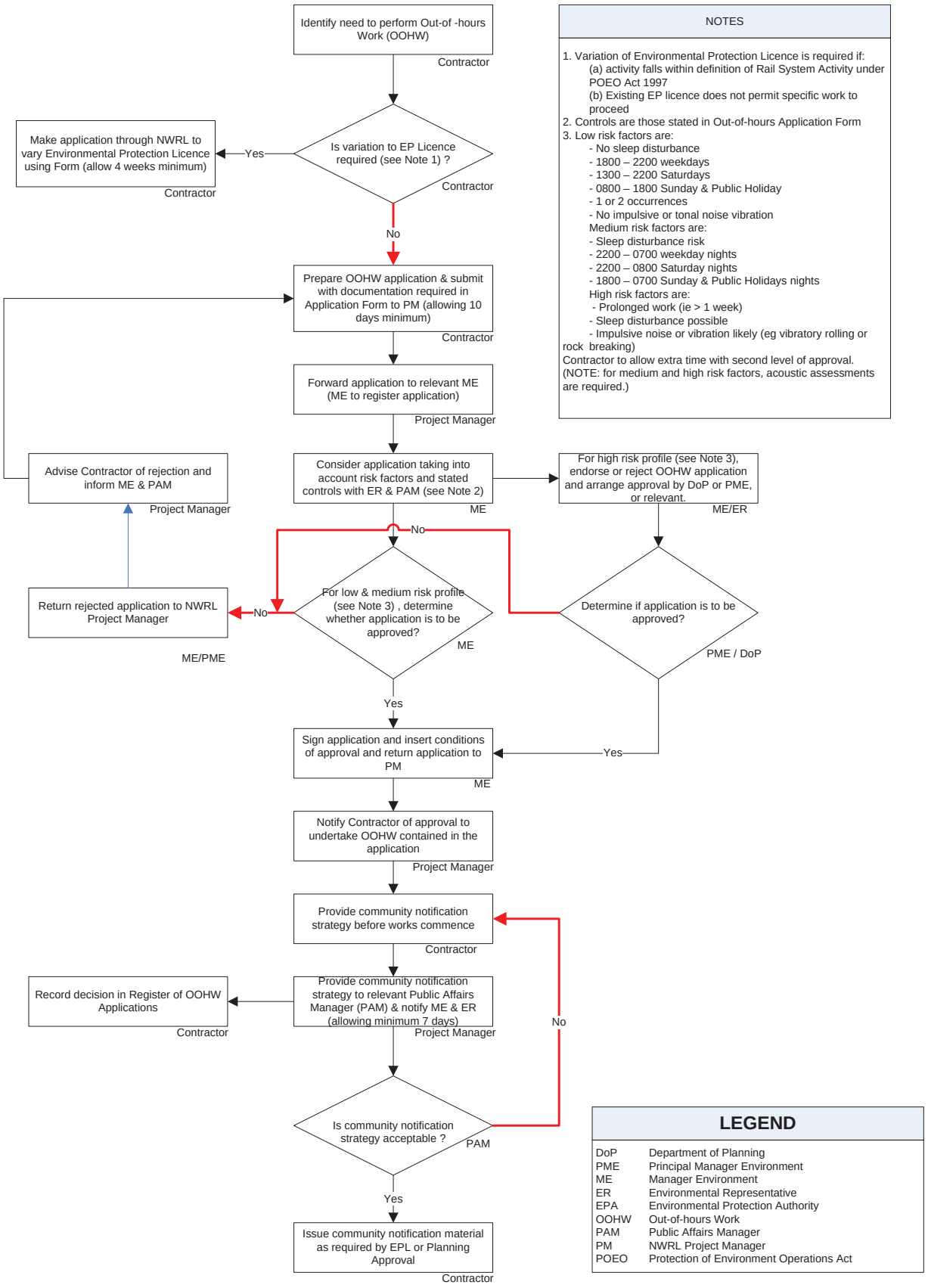

Figure 4.1 Out-of-hours Work Assessment and Approval Procedure

5 Mitigating Exceedances of Construction Noise and Vibration Objectives

5.1 Approach

As part of the environmental impact assessment process (refer Section 2 and Appendix B), it is necessary to identify feasible and reasonable mitigation measures (project specific) to minimise noise and vibration levels at the nearest receivers. In accordance with Section 3 of this CNVS, these measures are to be implemented as part of the standard mitigation measures (Table 3.1).

The implementation of the standard mitigation measures, compliance with maximum sound power levels for plant and equipment, construction hour management and standard community consultation measures in this CNVS should significantly reduce the noise and vibration impacts on nearby sensitive receivers.

Nevertheless, due to the highly variable nature of construction activities and the likelihood of work needing to be undertaken outside the standard construction hours, exceedances of the construction noise and vibration objectives are likely to occur.

Where there is a potential for the construction noise and vibration objectives to be exceeded, a number of additional measures to mitigate such exceedances– primarily aimed at pro-active engagement with affected sensitive receivers – should be explored and have been included in this CNVS. The additional mitigation measures to be applied are outlined in Table 5.1 below. A full description of each measure is provided in Appendix C.

Table 5.1 Additional Mitigation Measures

Measure	Abbreviation
Alternative accommodation	AA
Monitoring	M
Individual briefings	IB
Letter box drops[8]	LB
Project specific respite offer	RO
Phone calls	PC
Specific notifications	SN

[8] In certain circumstances, on a case by case basis, media advertising may also be used to supplement letter box drops where considered effective.

5.2 Applying Additional Mitigation Measures

In circumstances where - after application of the project specific and standard mitigation measures - the construction noise and vibration levels are still predicted[9] to exceed the noise or vibration objectives, the relevant Additional Mitigation Measures Matrix (AMMM) (see Tables 5.2 to 5.4 below) is to be used to determine the additional measures to be implemented.

Using the relevant AMMM, the following steps need to be carried out to determine the additional mitigation measures to be implemented:

1. Determine the time period when the work is to be undertaken
2. Determine the level of exceedance
3. From the relevant AMMM table, identify the additional mitigation measures to be implemented (using the abbreviation codes - expanded in Table 5.1).

Table 5.2 AMMM - Airborne Construction Noise

Time Period		**Mitigation Measures** $L_{Aeq(15minute)}$ **Noise Level Above Background (RBL) Qualitative Assessment of Noise Levels**[1]			
		0 to 10 dB Noticeable	**10 to 20 dB Clearly Audible**	**20 to 30 dB Moderately Intrusive**	**> 30 dB Highly Intrusive**
Standard	Mon-Fri (7.00 am - 6.00 pm)	-	-	LB, M	LB, M
	Sat (8.00 am - 1.00 pm)				
	Sun/Pub Hol (Nil)				
OOHW Period 1	Mon-Fri (6.00 pm - 10.00 pm)	-	LB	M, LB	M, IB, LB, RO, PC, SN
	Sat (1.00 pm - 10.00 pm)				
	Sun/Pub Hol (8.00 am - 6.00 pm)				
OOHW Period 2	Mon-Fri (10.00 pm - 7.00 am)	LB	M, LB	M, IB, LB, PC, SN	AA, M, IB, LB, PC, SN
	Sat (10.00 pm - 8.00 am)				
	Sun/Pub Hol (6.00 pm - 7.00 am)				

Notes:

1. For some types of construction activities (refer Appendix B), a qualitative assessment of the potential noise impacts can be undertaken in lieu of detailed noise modelling. For these activities, noise mitigation measures should be evaluated on the basis of the noise levels being noticeable, clearly audible, moderately intrusive or highly intrusive. The qualitative assessment should consider the type of equipment being used, the character of the noise emissions, time of day, the location of the nearest receivers and the noise sensitivity of the nearest receivers. Where a qualitative assessment is being undertaken, this will need to be approved by the EMR.

[9] In the CNVIS or other acoustic assessment

Table 5.3 AMMM – Ground-borne Construction Noise

Time Period		**Mitigation Measures** **Predicted $L_{Aeq(15minute)}$ Noise Level Exceedance** **Qualitative Assessment of Noise Levels**		
		0 to 10 dB **Clearly Audible**	**10 to 20 dB** **Moderately Intrusive**	**> 20 dB** **Highly Intrusive**
Standard	Mon-Fri (7.00 am - 6.00 pm)	LB	LB	M, LB, SN,
	Sat (8.00 am - 1.00 pm)			
	Sun/Pub Hol (Nil)			
OOHW Period 1	Mon-Fri (6.00 pm - 10.00 pm)	LB	M, LB, RO, SN,	M, IB, LB, PC, SN, RO
	Sat (1.00 pm - 10.00 pm)			
	Sun/Pub Hol (8.00 am - 6.00 pm)			
OOHW Period 2	Mon-Fri (10.00 pm - 7.00 am)	M, LB, SN,	AA, M, IB, LB, PC, RP, SN,	AA, M, IB, LB, PC, RP, SN,
	Sat (10.00 pm - 8.00 am)			
	Sun/Pub Hol (6.00 pm - 7.00 am)			

Table 5.4 AMMM – Ground-borne Vibration

Time Period		**Mitigation Measures** **Predicted Vibration Levels Exceed Maximum Levels**
Standard	Mon-Fri (7.00 am - 6.00 pm)	M, LB, RP
	Sat (8.00 am - 1.00 pm)	
	Sun/Pub Hol (Nil)	
OOHW Period 1	Mon-Fri (6.00 pm - 10.00 pm)	M, IB, LB, RO, PC, RP, SN,
	Sat (1.00 pm - 10.00 pm)	
	Sun/Pub Hol (8.00 am - 6.00 pm)	
OOHW Period 2	Mon-Fri (10.00 pm - 7.00 am)	AA, M, IB, LB, PC, RP, SN,
	Sat (10.00 pm - 8.00 am)	
	Sun/Pub Hol (6.00 pm - 7.00 am)	

5.3 Ground-borne Vibration

If the predicted ground-borne vibration levels exceed the cosmetic damage objectives in Appendix A, a different construction method with lower source vibration levels should be considered. Attended measurements should be undertaken at the commencement of all high vibration generating activities. If there is any risk of exceedance of the cosmetic damage objective, a permanent vibration monitoring system should be installed, to warn plant operators (via flashing light, audible alarm, SMS, etc) when vibration levels are approaching the cosmetic damage objective.

6 Documentation

A complaints management system will be utilised to maintain a record of all complaints received and the subsequent action taken, in accordance with the approval and licence conditions.

Contractors are to retain records of the following:

- Complaints records (i.e. time and nature of complaint)
- Complaints responses and close out actions
- Correspondence
- Monitoring results
- Mitigation measures
- Construction Environmental Management Plans and associated sub-plans.

7 References

- AS 1055.1 1997, *Acoustics - Description and Measurement of Environmental Noise - General Procedures*. Standards Australia.
- AS 2107, 2000, *Acoustics – Recommended design sound levels and reverberation times for building interiors*. Standards Australia.
- AS 2187, Part 2, 2006, *Explosives - Storage and Use - Part 2: Use of Explosives*. Standards Australia.
- AS 2436, 2010, *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*. Standards Australia.
- AS/NZS 1269, *Occupational Noise Management Series – Parts 0 to 4*. Standards Australia.
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- DECC, 2009, *Interim Construction Noise Guideline*. Department of Environment and Climate Change NSW.
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- TCA, 2011, *Construction Noise Strategy – Version 1.0 – 13 September 2011*. Transport Construction Authority.

Appendix A Overview of Construction Noise and Vibration Objectives

This appendix provides a brief overview of construction noise and vibration and its potential effects on people, buildings and their contents. It also provides guidance on how to establish construction noise and vibration objectives during the environmental assessment phase.

A.1 Construction Airborne Noise Objectives

Where a quantitative noise assessment is to be undertaken, the construction airborne noise objectives are based on DECC's *"Interim Construction Noise Guideline"* (2009).

The interim guideline contains noise management levels for sensitive land uses including commercial and industrial receivers. These are provided in Table A.1 and Table A.2. At locations where the predicted construction noise levels exceed the noise management levels, the proponent should apply all feasible and reasonable work practices, document these within the environmental impact assessment and implement the proposed work practices as part of the standard mitigation measures (refer Table 3.1).

Where the predicted construction noise levels remain above the noise management levels after implementation of all feasible and reasonable work practices, the relevant AMMM is to be implemented (refer Section 5), based on the predicted $L_{Aeq(15minute)}$ noise levels. These are primarily aimed at pro-active engagement with affected sensitive receivers. When communicating with sensitive receivers impacted by the construction works, the guidelines in the *"how to apply"* column should be followed.

Table A.1 Airborne Noise Objectives at Residences Using Quantitative Assessment

Time of Day	Noise Management Level $L_{Aeq(15minute)}$	How to Apply
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm Saturday 8.00 am to 1.00 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see Section 7.2.2 of the *Interim Construction Noise Guideline*.

The L_{A90} Rating Background Levels (RBL's) should be determined using the *"tenth percentile method"* described in EPA's *"NSW Industrial Noise Policy"* (2000) during the relevant assessment periods (daytime, evening or night-time).

Table A.2 Airborne Noise Objectives at Sensitive Land Uses (other than Residential) Using Quantitative Assessment

Land Use	**Management Level, LAeq(15minute)** **(Applies when Land Use is being Utilised)**
Classrooms at schools and other educational institutions	Internal noise level 45 dBA
Hospital wards and operating theatres	Internal noise level 45 dBA
Places of Worship	Internal noise level 45 dBA
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dBA
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dBA
Community Centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

Due to the broad range of sensitivities that commercial or industrial land can have to noise from construction, the process of defining management levels is separated into three categories. The external noise levels should be assessed at the most-affected occupied point of the premises:

- Industrial premises: external $L_{Aeq(15minute)}$ 75 dBA
- Offices, retail outlets: external $L_{Aeq(15minute)}$ 70 dBA
- Other businesses that may be very sensitive to noise, where the noise level is project specific as discussed below.

Examples of other noise-sensitive businesses are theatres and child care centres. The proponent should undertake a special investigation to determine suitable noise levels on a project-by-project basis; the recommended 'maximum' internal noise levels in AS 2107 *"Acoustics – Recommended design sound levels and reverberation times for building interiors"* may assist in determining relevant noise levels.

The proponent should assess construction noise levels for the project, and consult with occupants of commercial and industrial premises prior to lodging an application where required. During construction, the proponent should regularly update the occupants of the commercial and industrial premises regarding noise levels and hours of work.

A.2 Construction Ground-borne Noise Objectives

Construction ground-borne noise objectives are based on DECC's *"Interim Construction Noise Guideline"* (2009).

Ground-borne construction noise is usually present on tunnelling projects when equipment such as tunnel boring machines, road headers, rock hammers and drilling rigs are operated underground. The ground-borne noise inside buildings initially propagates as ground-borne vibration, before entering the building, which causes floors, walls and ceilings to gently vibrate and hence radiate noise. Sometimes the vibration may be perceptible within the building. For some critical spaces such as recording studios and cinemas, which are designed to reduce airborne noise intrusion, an assessment of ground-borne construction noise for surface construction may also be required.

Ground-borne noise is usually not a significant disturbance to building occupants during daytime periods due to higher ambient levels which mask the audibility of ground-borne noise emissions. During night-time periods however, when ambient noise levels are often much lower, ground-borne noise is more prominent and may result in adverse comment from building occupants.

Table A.3 provides a summary of the ground-borne construction noise objectives.

Table A.3 Ground-borne Noise Objectives at Residences

Time of Day	**Ground-borne Noise Objectives $L_{Aeq(15minute)}$**
Daytime 7.00 am to 6.00 pm	Human comfort vibration objectives only
Evening 6.00 pm to 10.00 pm	40 dBA - Internal
Night-time 10.00 pm to 7.00 am	35 dBA - Internal

A.3 Construction Vibration Objectives

The effects of vibration in buildings can be divided into three main categories; those in which the occupants or users of the building are inconvenienced or possibly disturbed, those where the building contents may be affected and those in which the integrity of the building or the structure itself may be prejudiced.

Human Perception of Vibration

Guidance in relation to acceptable vibration levels for human comfort are provided in DEC's *"Assessing Vibration: a technical guideline"* (2006).

The DEC guideline provides three assessment methods, depending on whether the vibration is continuous, impulsive or intermittent. The preferred and maximum values are provided in Table A.4.

- **Continuous vibration** would normally be generated by fixed plant items such as generators, fans and the like where the vibration emissions continue uninterrupted (usually throughout the daytime or night-time period).
- **Impulsive vibration** would normally be generated by short duration (ie less than two second) events with no more than three occurrences in an assessment period. A typical example would be ground compaction by dropping a large mass. Higher levels are allowed for impulsive vibration, however if more than three impulsive vibration events occur during the assessment period, the more stringent intermittent objectives are applied.

Table A.4 Preferred and Maximum Vibration Levels for Human Comfort

Location	Assessment Period	Preferred Values		Maximum Values	
Continuous Vibration		**z axis**	**x and y axes**	**z axis**	**x and y axes**
Critical areas	Day- or night-time	0.005 m/s^2	0.0036 m/s^2	0.010 m/s^2	0.0072 m/s^2
Residences	Daytime	0.010 m/s^2	0.0071 m/s^2	0.020 m/s^2	0.014 m/s^2
	Night-time	0.007 m/s^2	0.005 m/s^2	0.014 m/s^2	0.010 m/s^2
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020 m/s^2	0.014 m/s^2	0.040 m/s^2	0.028 m/s^2
Workshops	Day- or night-time	0.040 m/s^2	0.029 m/s^2	0.080 m/s^2	0.058 m/s^2
Impulsive Vibration		**z axis**	**x and y axes**	**z axis**	**x and y axes**
Critical areas	Day- or night-time	0.005 m/s^2	0.0036 m/s^2	0.010 m/s^2	0.0072 m/s^2
Residences	Daytime	0.30 m/s^2	0.21 m/s^2	0.60 m/s^2	0.42 m/s^2
	Night-time	0.10 m/s^2	0.071 m/s^2	0.20 m/s^2	0.14 m/s^2
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64 m/s^2	0.46 m/s^2	1.28 m/s^2	0.92 m/s^2
Workshops	Day- or night-time	0.64 m/s^2	0.46 m/s^2	1.28 m/s^2	0.92 m/s^2
Intermittent Vibration		**x, y and z axes**		**x, y and z axes**	
Critical Areas	Day- or night-time	0.10 $m/s^{1.75}$		0.20 $m/s^{1.75}$	
Residences	Daytime	0.20 $m/s^{1.75}$		0.40 $m/s^{1.75}$	
	Night-time	0.13 $m/s^{1.75}$		0.26 $m/s^{1.75}$	
Offices, schools, educational institutions and places of worship	Day- or night-time	0.40 $m/s^{1.75}$		0.80 $m/s^{1.75}$	
Workshops	Day- or night-time	0.80 $m/s^{1.75}$		1.60 $m/s^{1.75}$	

Notes:

For continuous and intermittent vibration, the preferred and maximum values are weighted acceleration values (Wg for z axis and Wd for x and y axes).

For intermittent vibration, the preferred and maximum values are Vibration Dose Values (VDVs), based on the weighted acceleration values

- **Intermittent vibration** can be defined as interrupted periods of continuous vibration (eg vibratory rolling, heavy truck passbys or rock breaking) or continuous periods of impulsive vibration (eg impact pile driving). Higher vibration levels are allowed for intermittent vibration compared with continuous vibration on the basis that the higher levels occur over a shorter time period. Hence, for intermittent vibration, human comfort vibration levels are assessed on the basis of the Vibration Dose Value (VDV), based on the level and the duration of the vibration events.

Effects on building contents

People can perceive floor vibration at levels well below those likely to cause damage to building contents or affect their operation. For most receivers, the controlling vibration criterion is therefore the human comfort criterion and separate objectives are not normally required in relation to the effect of construction vibration on building contents.

Some scientific equipment (eg electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort. Where appropriate, objectives for the satisfactory operation of critical instruments or manufacturing processes should be sourced from manufacturer's data and/or other published objectives.

Effects of vibration on structures

The levels of vibration required to cause cosmetic damage to buildings tend to be at least an order of magnitude (10 times) higher than those at which people may consider the vibration to be intrusive.

In terms of the most recent relevant vibration damage objectives, Australian Standard AS 2187: Part 2-2006 *"Explosives - Storage and Use - Part 2: Use of Explosives"* recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2"* as they *"are applicable to Australian conditions"*.

The British Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) from BS7385 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table A.5 and graphically in Figure A.1.

Table A.5 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

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

The standard states that the guide values in Table A.5 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide

values in Table A.5 may need to be reduced by up to 50% - ie 7.5 mm/s at 4 Hz (as shown by Line 3 of Figure A.1 for Residential Buildings).

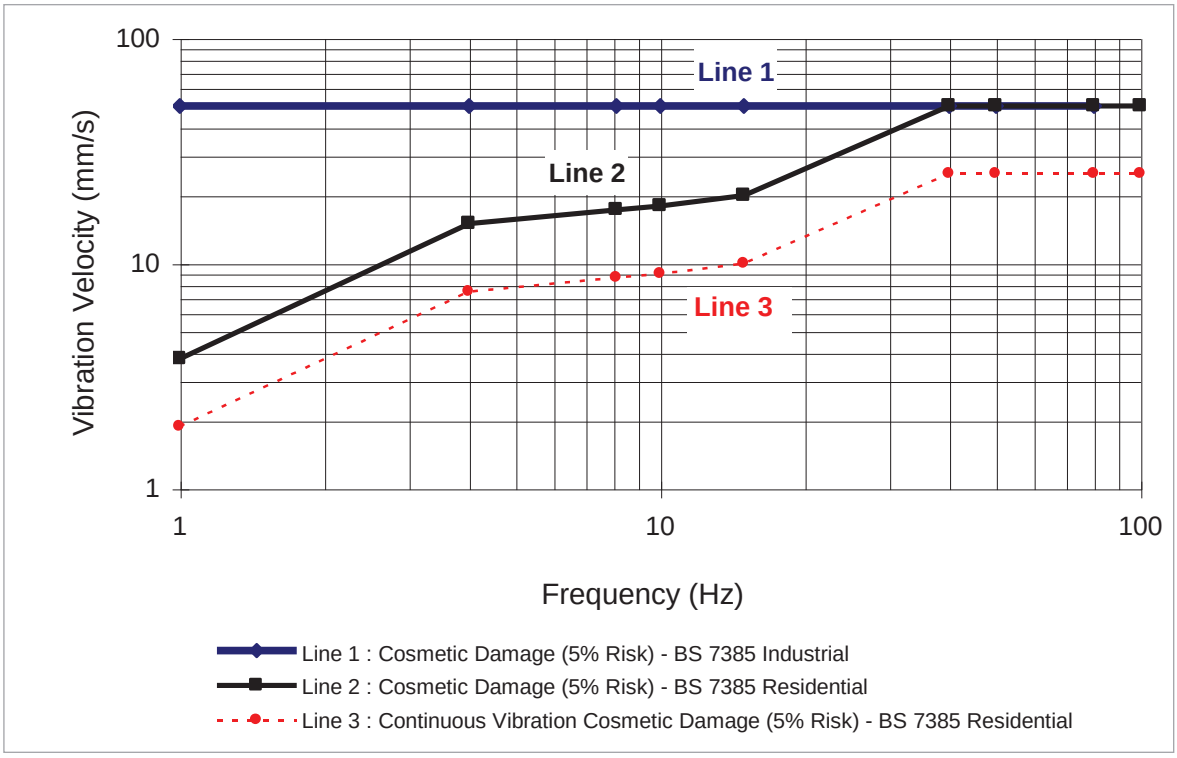

Figure A.1 Graph of Transient Vibration Guide Values for Cosmetic Damage

In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in Table A.5 and major damage to a building structure may occur at values greater than 4 times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in Table A.5 should not be reduced for fatigue considerations.

It is noteworthy that, extra to the guide values nominated in Table A.5, the standard states that:

"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."

Also that:

"A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."

In relation to standards used for assessing the risk of vibration damage to structures, the Department of Planning guideline *"Development Near Rail Corridors and Busy Roads – Interim Guideline"* also refers to German Standard DIN 4150 Part 3 1999 *"Structural vibration - Effects of vibration on structures"*. In situations where excavation and other earthworks are undertaken in and around the railway corridor, the potential vibration impacts shall consider the vibration criteria in BS 7385 Part 2-1993 and DIN 4150 Part 3 1999.

Construction-related traffic noise goals

On the roads immediately adjacent to construction sites, the community may associate heavy vehicle movements with the project. Once the heavy vehicles move further from construction sites onto major collector or arterial roads however, the noise may be perceived as part of the general road traffic.

In most situations, it may be sufficient to undertake a qualitative assessment of the potential noise impacts associated with heavy vehicle movements, however for spoil removal sites it is likely a quantitative assessment will be required. This assessment should take into consideration the number of heavy vehicle movements per hour or shift, the proximity of sensitive receivers, the duration of the construction works and the time of day. Where a qualitative assessment is being undertaken, this will need to be approved by the EMR.

If a quantitative assessment is required, construction-related traffic noise goals should be based on the guidance contained in DECCW's *"NSW Road Noise Policy"* (RNP). If the heavy vehicle movements occur during the 10.00 pm to 7.00 am night-time period, guidance on the potential for sleep disturbance is contained in the *"Application Notes to the NSW Industrial Noise Policy"*.

Appendix B Guidelines for Assessing Noise & Vibration Impacts (Including CNVIS)

Whenever construction works are proposed as part of a project, a prediction and assessment of the airborne noise, ground-borne noise and ground-borne vibration levels is required to determine the potential impacts on nearby receivers. The determination of the mitigation measures required will depend on the level of impact, the duration of the works and the time at which the noise or vibration activity occurs.

The intention is to minimise the level of site noise and vibration and inconvenience to affected receivers while having regard to the feasibility and reasonableness of any proposed control or mitigation measures.

B.1 Type of Assessment

The level of detail for a construction assessment will vary depending on the scale of the works and the likely noise and vibration impacts.

For some small construction sites, involving low-powered plant where sensitive receivers are not located in close proximity to the works, it may be sufficient to undertake a qualitative assessment of the potential noise and vibration impacts. DECC's *"Interim Construction Noise Guideline"* indicates that short-term means that the works are not likely to affect an individual or sensitive land use for more than three weeks in total.

For larger construction sites, involving many plant items and extended periods of construction adjacent to sensitive receivers, a quantitative assessment of the potential noise and vibration impacts is required (although some activities or work stages may still require only a qualitative assessment).

The construction of a chain wire safety fence as part of preparatory works during the daytime or evening period, for example, may require only a qualitative assessment of the potential noise impacts. However, the construction of a new bridge out of hours over a period of 4 weeks would require a quantitative assessment of the potential noise and vibration impacts.

Where a qualitative assessment is being undertaken, this will need to be approved by the EMR.

The noise and vibration impact assessments should be undertaken in accordance with the guidance provided in this CNVS and the relevant Environment Protection Licence (EPL) conditions.

B.2 Qualitative Assessment Procedure

For qualitative construction assessments, the following minimum requirements would need to be included as part of the assessment report:

- Justification for undertaking a qualitative assessment including endorsement by EMR
- Duration of the construction works and time periods over which works will be undertaken
- Equipment expected to be used (during noisiest operations)
- Identification and description of nearest sensitive receivers potentially impacted by the proposed construction works

- List of standard mitigation measures that will be employed to minimise the potential noise impacts (including management measures, source controls and path controls)
- Discussion of the Qualitative Assessment with reference to the relevant Additional Mitigation Measures Matrix (AMMM) in Tables 5.2 to 5.4
- List of additional mitigation measures that will be employed to minimise the potential impacts (including monitoring and management measures)
- Documented complaints management process including a strategy for identifying any additional mitigation measures that may be required.

B.3 Quantitative Assessment Procedure

Quantitative construction assessments are performed by comparing the predicted noise and vibration levels with the appropriate objectives for the receiver types and time of day.

Quantitative assessment reports will need to address the same minimum requirements as per the qualitative assessment procedure above, plus detailed information in relation to the source noise levels, the determination of appropriate noise and vibration objectives, relevant construction scenarios and predicted noise and vibration levels.

The quantitative assessment procedure steps are as follows:

Step 1: Determine noise and vibration objectives

The relevant noise and vibration objectives for the nearest sensitive receivers that may be potentially impacted by the construction works should be determined with reference to Appendix A.

Step 2: Assess construction scenarios

Identify a representative range of construction scenarios.

If the assessment is being carried out for the environmental impact assessment documentation (eg EIS or REF) it will be based on a concept design and construction scenarios for the project (usually prepared by a technical advisor and/or planning consultant).

If the assessment is being undertaken prior to construction (eg CNVIS) it will be based on a more detailed design and actual construction scenario (usually prepared by the design and/or construction contractors).

The assessment should be conservative and sufficiently detailed to identify any project specific noise or vibration mitigation measures (including, but not limited to: physical structures such as construction hoardings, acoustic sheds, dwelling treatments, acoustic barriers around noisy plant, operational noise barriers erected early or special construction methods such as penetrating cone fracture or controlled blasting in place of conventional rock breaking) that are both necessary to meet the construction noise or vibration objectives and feasible and reasonable to implement.

In determining feasible and reasonable mitigation measures, proponents are directed to DECC's *"Interim Construction Noise Guideline"* which provides several worked examples on how construction noise can be minimised at sensitive receivers (particularly section 6 and Appendix A). Proponents are also directed to Appendix C and Appendix D of Australian Standard 2436-2010 *"Guide to noise and vibration control on construction, demolition and maintenance sites"*.

In predicting the level of noise or vibration at nearby sensitive receivers, the assessment (whether based on concept or detailed design) must include the implementation of all relevant mitigation measures in Table 3.1.

Step 3: Predicting noise and/or vibration impacts

For airborne construction noise

1. Determine the source noise levels (SWLs) of each plant item proposed as part of the construction scenario. Note that the noise levels (SWLs) of each plant or equipment item should be less than the maximum allowable levels in Table 3.2. If the noise from a particular plant item is tonal or impulsive in nature, a 5 dB penalty should be added to the noise source level.

2. Determine the location of each plant or equipment item in relation to each receiver.

3. Include the effects of all project specific (see above) mitigation measures.

4. Include the effects of all relevant standard mitigation measures.

5. Include the effects of noise shielding provided by site offices, noise barriers or natural topographic features.

6. Include the effects of noise reflections and ground attenuation.

7. On the basis of the duration of each activity (over a typical "worst-case" 15-minute period), determine whether any correction between the L_{Amax} and $L_{Aeq(15minute)}$ is required.

8. Calculate the $L_{Aeq(15minute)}$ noise levels from the proposed construction activities at each receiver and compare these with the airborne construction noise objectives.

9. For night-time activities, calculate the maximum (L_{Amax}) noise levels and compare with the OEH's RBL plus 15 dB sleep disturbance screening criterion (refer *"Application Notes to the NSW Industrial Noise Policy"*). Factors that may be important in assessing the extent of impact on sleep include how often high noise events occur at night, the predicted maximum noise levels at night, whether there are times when there is a clear change in the noise environment (such as during early morning shoulder periods), and the degree to which maximum noise levels are above the background noise level at night.

Notes:

The number of receivers would be dependent on the size of the construction site, the time at which the construction noise occurs and the level of potential noise impact. Calculations would normally be undertaken at locations considered to be representative of a group of receivers with a similar level of exposure to the construction works.

For night-time construction works or large construction sites with many nearby receivers, it may be more appropriate to provide noise contour plots in order to illustrate the degree to which each receiver or group of receivers are impacted by the construction works.

For ground-borne construction noise

1. Determine the location of each plant or equipment item in relation to each receiver.

2. On the basis of ground-borne noise levels versus distance prediction curves for each plant item, determine the level of ground-borne noise at each building location. For highly sensitive building occupancies, the assessment may need to incorporate the acoustic properties of the building space and the structural response of the building.

3. Include the effect of all relevant standard mitigation measures as part of the construction scenario.

4. Calculate the $L_{Aeq(15minute)}$ noise levels from the proposed construction activities at each receiver and compare these with the ground-borne construction noise objectives.

For ground-borne construction vibration

1. Determine the location of each plant or equipment item in relation to each receiver.

2. On the basis of ground-borne vibration levels versus distance prediction curves for each plant item, determine the level of ground-borne vibration at each building location. For highly sensitive equipment, the assessment may need to incorporate the structural response of the building and particular sensitivities of the equipment.

3. Incorporate all relevant standard mitigation measures as part of the construction scenario.

4. Calculate the continuous, intermittent and impulsive vibration levels from the proposed construction activities at each receiver and compare these with the ground-borne construction vibration objectives.

Step 4: Determining additional mitigation measures required

1. Consult the relevant Additional Mitigation Measures Matrix (AMMM) in Tables 5.2 to 5.4 to determine, based on the level of exceedance of the background noise or ground-borne noise or vibration level, the additional mitigation measures to be implemented.

Appendix C Standard and Additional Mitigation Measures

Community Relations plan

For each worksite, a Community Relations plan will be developed outlining additional mitigation measures and communication activities. At a minimum these will include signage with project contact details at each site, 7 days notification before noisy work begins and responding to complaints within 1 day. These will be tailored to meet the needs of impacted stakeholders but may include the activities outlined below.

Periodic notification (monthly letterbox drop or advertisement in local papers)

For the NWRL, a newsletter entitled 'Project Update' or 'Construction Update' will be produced and distributed to the local community via letterbox drop and the project mailing list or the same information will be advertised in the local paper and distributed to the project mailing list. These will provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage, inform and provide project-specific messages. Advanced warning of potential disruptions (eg traffic changes, noisy works or TBM movements) can assist in reducing the impact on the community. The approval conditions for projects specify requirements for notification to the community about works that may impact on them.

Website

The NWRL project website (http://northwestrail.com.au/) will serve as a key resource for members of the community to seek further information on the project, including noise and vibration management plans, current and upcoming construction activities. It will be available on a 24-hour basis and provides a constant and additional layer of information over-and-above the periodic notifications.

The website is reviewed and updated on a monthly basis or in line with construction works.

As the website is a public forum, all information to be uploaded is approved by NWRL's Deputy Project Director, Stakeholder and Community Engagement. The aim is to provide a visually appealing, easy-to-navigate tool for members of the public. Information is provided in plain English with use of illustrative graphics and photos and a minimum of jargon.

Project Infoline

A free-call project information telephone number has been set up for the NWRL project and will provide a contact point for interested stakeholders:

- **Project Infoline, 1800 019 989** – providing a dedicated contact point for any project enquiries.

This line is answered by staff at the NWRL Community Information Centre and is the key mechanism for the receipt of enquiries/complaints in relation to the NWRL project. This numbers is listed with Telstra and is advertised in all project-related communications materials.

During the construction stage, all complaints received directly by community relations personnel will require a verbal acknowledgement within 2 hours. All enquiries will require a verbal response (confirming actions to be undertaken) within 24 hours during standard construction hours, or on the next working day during out of hours work (unless the enquirer agrees otherwise).

Project team members will be available 24 hours per day during construction to ensure complaints are managed by experienced personnel to facilitate swift resolution.

Email distribution list

Email distribution lists may be used to disseminate project information to interested stakeholders. Advanced warning of audible activities can assist to reduce the impact of projects experienced by the community.

NWRL and its contractors maintain mailing lists of stakeholders interested in receiving project information via email.

Signage

Signage will be provided at each construction site to notify stakeholders of project details and project emergency and enquiry contact information. Where possible and when appropriate, the full community notification, detailing likely audible construction noise will be on display at the work site.

Specific notifications (SN)

Specific notifications are letterbox dropped or hand distributed to identified stakeholders no later than seven days ahead of construction activities that are likely to exceed the noise objectives. The exact conditions under which specific notifications would proceed are defined in the relevant Additional Mitigation Measures Matrix (Tables 5.2 to 5.4). This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Phone calls (PC)

Phone calls may be made to identified/affected stakeholders within seven days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.

Individual briefings (IB)

Individual briefings may be used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.

Project specific respite offer (RO)

Residents subjected to lengthy periods of noise or vibration may be eligible for a project specific respite offer. The purpose of such an offer is to provide residents with respite from an ongoing impact. The offer could comprise pre-purchased movie tickets or similar offer. This measure is determined on a project-by-project basis, and may not be applicable to all construction sites.

The project may also consider other mitigation measures such as noise cancelling headsets or installing double-glazed/insulated windows to reduce noise reception for sensitive receivers.

Alternative accommodation (AA)

NWRL will consider providing alternative accommodation options for residents living in close proximity to construction works that are likely to incur noise levels significantly above the applicable level (Tables 5.2 to 5.4). The value of the offer will be determined on a site-by-site basis.

Appendix K Construction Noise Level Tables

This appendix provides a summary of the predicted $L_{Aeq(15minute)}$ noise levels for each site and construction scenario, the noise management levels (NMLs) for each receiver area and the predicted NML exceedances.

A detailed description of the construction scenarios and receiver areas is provided in Chapter 12. Separate noise level tables are provided for each construction site and noise modelling scenario.

K.1 Epping Services Facility and Decline Tunnel

Table K.1 Decline Tunnel Site Predicted Noise Levels - Delivery of Materials

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	29	55	nil
B	Commercial	32	70	nil
C	Educational (School)	31	55	nil
D	Commercial	33	70	nil
E	Church	35	65	nil
F	Residential	52	55	nil
G	Residential	53	55	nil

Table K.2 Epping Services Facility Predicted Noise Levels - Services Building and Supporting Structure Construction

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	43	55	nil
B	Commercial	43	70	nil
C	Educational (School)	37	55	nil
D	Commercial	34	70	nil
E	Church	43	65	nil
F	Residential	52	55	nil
G	Residential	66	55	up to 11

Table K.3 Epping Services Facility Predicted Noise Levels – Installation of Rail Systems

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	38	55	nil
B	Commercial	40	70	nil
C	Educational (School)	42	55	nil
D	Commercial	48	70	nil
E	Church	48	65	nil
F	Residential	63	55	up to 8
G	Residential	46	55	nil

K.2 Cheltenham Oval Services Facility

Table K.4 Cheltenham Oval Services Facility Predicted Noise Levels - Services Building and Supporting Structure Construction

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	38	59	nil
B	Residential	66	59	up to 7
C	Residential	45	65	nil
D	Residential	41	65	nil
E	Active Recreational (Oval)	51	65	nil

Table K.5 Cheltenham Oval Services Facility Predicted Noise Levels – Installation of Rail Systems Equipment

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	35	59	nil
B	Residential	61	59	up to 2
C	Residential	42	65	nil
D	Residential	37	65	nil
E	Active Recreational (Oval)	46	65	nil

K.3 Cherrybrook Station

Table K.6 Cherrybrook Station Predicted Noise Levels - Station Platform Supporting Structure, Station Building Construction and Car park Construction

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	70	47	up to 22
B	Residential	69	47	up to 22
C	Educational (School)	46	55	Nil
D	Educational (School)	49	55	Nil
E	Residential	54	55	Nil
F	Residential	55	55	Nil
G	Residential	57	55	up to 2
G	Childcare	53	50	up to 3

Table K.7 Cherrybrook Station Predicted Noise Levels – Installation of Rail Systems Equipment.

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	52	47	up to 5
B	Residential	49	47	up to 2
C	Educational (School)	40	55	Nil
D	Educational (School)	43	55	Nil
E	Residential	47	55	Nil
F	Residential	52	55	Nil
G	Residential	56	55	up to 1
G	Childcare	54	50	up to 5

K.4 Castle Hill Station

Table K.8 Castle Hill Predicted Noise Levels - Station Platform Supporting Structure, Station Building Construction and Car park Construction

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Commercial	61	70	nil
B	Commercial	72	70	up to 2
C	Residential	54	60	nil
D	Residential	51	60	nil
E	Residential	58	60	nil
F	Commercial	69	70	nil

Table K.9 Castle Hill Predicted Noise Levels – Installation of Rail Systems Equipment

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Commercial	62	70	nil
B	Commercial	65	70	nil
C	Residential	49	60	nil
D	Residential	47	60	nil
E	Residential	60	60	nil
F	Commercial	60	70	nil

K.5 Showground Station

Table K.10 Showground Predicted Noise Levels - Station Platform Supporting Structure, Station Building Construction and Car park Construction

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Commercial	59	70	nil
B	Commercial	47	70	nil
C	Active Recreation	56	65	nil
D	Residential	45	64	nil
E	Residential	61	64	nil
E	Childcare	61	50	11

Table K.11 Showground Predicted Noise Levels – Installation of Rail Systems Equipment

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Commercial	44	70	nil
B	Commercial	43	70	nil
C	Active Recreation	41	65	nil
D	Residential	53	64	nil
E	Residential	56	64	nil
E	Childcare	56	50	6

K.6 Norwest Station

Table K.12 Norwest Predicted Noise Levels - Station Building and Support Structure Construction

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Commercial	70	70	nil
B	Residential	53	57	nil
C	Other (Church)	47	65	nil
D	Commercial	60	70	nil

Table K.13 Norwest Predicted Noise Levels – Installation of Rail Systems Equipment

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Commercial	65	70	nil
B	Residential	48	57	nil
C	Other (Church)	41	65	nil
D	Commercial	51	70	nil

K.7 Bella Vista Station Site

Table K.14 Bella Vista Predicted Noise Levels - Station platform, Supporting Structure, Station Building Construction

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	33	46	nil
B	Residential	40	46	nil
C	Residential	45	46	nil
D	Commercial	58	70	nil
E	Residential	43	56	nil
F	Other (Church)	43	65	nil
G	Residential	47	61	nil
H	Residential	39	61	nil
I	Commercial	33	70	nil
J	Residential	30	61	nil

Table K.15 Bella Vista Predicted Noise Levels - Installation of Rail Systems Equipment

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	33	46	nil
B	Residential	40	46	nil
C	Residential	45	46	nil
D	Commercial	55	70	nil
E	Residential	43	56	nil
F	Other (Church)	40	65	nil
G	Residential	46	61	nil
H	Residential	38	61	nil
I	Commercial	33	70	nil
J	Residential	30	61	nil

K.8 Kellyville Station

Table K.16 Kellyville Station Predicted Noise Levels - Station platform, Supporting Structure, Station Building Construction, Escalator/lift/stair Construction and Car park Construction

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	44	49	nil
B	Residential	51	49	up to 2
C	Residential	43	49	nil
D	Residential	40	55	nil
E	Residential	53	55	nil

Table K.17 Kellyville Station Predicted Noise Levels – Installation of Rail Systems Equipment

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	37	49	nil
B	Residential	42	49	nil
C	Residential	34	49	nil
D	Residential	35	55	nil
E	Residential	49	55	nil

K.9 Rouse Hill Station

Table K.18 Rouse Hill Station Predicted Noise Levels - Station platform, Supporting Structure, Station Building Construction, Escalator/lift/stair Construction and Car park Construction

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Commercial	64	70	nil
B	Active Recreational	38	65	nil
C	Residential	38	51	nil
D	Residential	38	62	nil
E	Other (passive recreation)	39	60	nil
F	Residential	60	61	nil
G	Commercial	61	70	nil

Table K.19 Rouse Hill Station Predicted Noise Levels – Installation of Rail Systems Equipment

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Commercial	59	70	nil
B	Active Recreational	36	65	nil
C	Residential	36	51	nil
D	Residential	36	62	nil
E	Other (passive recreation)	35	60	nil
F	Residential	60	61	nil
G	Commercial	61	70	nil

K.10 Cudgegong Road Station and Tallawong Stabling Facility

Table K.20 Cudgegong Road Station and Train Stabling Facility Predicted Noise Levels - Installation of Tracks and the Construction of Buildings - Train Stabling Facility

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	46	54	nil
B	Residential	36	54	nil
C	Residential	36	55	nil
D	Residential	45	55	nil
E	Residential	51	53	nil
F	Residential	48	53	nil

Table K.21 Cudgegong Road Station and Train Stabling Facility Predicted Noise Levels - Rail systems installation – Train Stabling Facility

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	32	54	nil
B	Residential	22	54	nil
C	Residential	22	55	nil
D	Residential	31	55	nil
E	Residential	37	53	nil
F	Residential	34	53	nil

Table K.22 Cudgegong Road Station and Train Stabling Facility Predicted Noise Levels - Station Construction including Car parks - Cudgegong Road Station only.

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	75	54	up to 21
B	Residential	50	54	nil
C	Residential	42	55	nil
D	Residential	41	55	nil
E	Residential	33	53	nil
F	Residential	41	53	nil

Table K.23 Cudgegong Road Station and Train Stabling Facility Predicted Noise Levels - Station Rail Systems - Cudgegong Road Station only

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	45	54	nil
B	Residential	46	54	nil
C	Residential	35	55	nil
D	Residential	33	55	nil
E	Residential	27	53	nil
F	Residential	32	53	nil

K.11 Bella Vista Station to Kellyville Station

Table K.24 Bella Vista Station to Kellyville Station Viaduct Predicted Noise Levels - Concrete Pouring, Installation of Stanchions and Track Construction

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	57	49	up to 8
B	Residential	53	49	up to 4
C	Residential	64	57	Up to 7
D	Commercial	64	70	nil

Table K.25 Bella Vista Station to Kellyville Station Viaduct Predicted Noise Levels - Overhead Wiring Installation

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	49	49	nil
B	Residential	45	49	nil
C	Residential	56	57	nil
D	Commercial	56	70	nil

K.12 Kellyville Station to Rouse Hill Station

Table K.26 Kellyville Station to Rouse Hill Station Viaduct Predicted Noise Levels - Concrete Pouring, Installation of Stanchions and Track Construction

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	73	55	Up to 18
B	Residential	64	62	up to 2
C	Educational (School)	55	55	nil
C	Commercial	64	70	Nil
D	Other (passive recreation)	49	60	Nil
E	Residential	73	51	Up to 22
F	Active Recreational (tennis & playground)	67	65	up to 2
G	Commercial	70	70	nil

Table K.27 Kellyville Station to Rouse Hill Station Viaduct Predicted Noise Levels - Overhead Wiring Installation

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Residential	65	55	Up to 10
B	Residential	56	62	Nil
	Educational (School)	47	55	Nil
C	Commercial	56	70	Nil
D	Other (passive recreation)	41	60	Nil
E	Residential	65	51	Up to 14
F	Active Recreational (tennis & playground)	59	65	nil
G	Commercial	62	70	nil

K.13 Rouse Hill Station to Cudgegong Road Station

Table K.28 Rouse Hill Station to Cudgegong Road Station Viaduct Predicted Noise Levels - Concrete Pouring, Installation of Stanchions and Track Construction

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Commercial	75	70	Up to 5
B	Other (passive recreation)	49	60	nil
C	Residential	54	61	nil
D	Residential	90	54	Up to 36

Table K.29 Rouse Hill Station to Cudgegong Road Station Viaduct Predicted Noise Levels - Overhead Wiring Installation

Receiver Area	Receiver Type	Noise Level – $L_{Aeq(15minute)}$ (dBA)		
		Worst-case Predicted	NML	Exceedance
			Daytime	Daytime
A	Commercial	67	70	nil
B	Other (passive recreation)	41	60	nil
C	Residential	46	61	nil
D	Residential	82	54	Up to 28