Sydney Metro City and Southwest – North Corridor Works
Technical Report - Noise Monitoring – OOHW P7: 20 to 21 October 2018

Project

<table>
<thead>
<tr>
<th>Title</th>
<th>Technical Report – Noise Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client</td>
<td>Sydney Metro City and Southwest</td>
</tr>
<tr>
<td>Document Reference No.</td>
<td>LOR-NCW-Noise Monitoring_WE16 OOHW P7 - 201018_211018.docx</td>
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<tr>
<td>Laing O’Rourke Project No.</td>
<td>K38</td>
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Document

<table>
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<tr>
<th>Date</th>
<th>26 October 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring Period</td>
<td>Saturday, 20 October to Sunday, 21 October 2018</td>
</tr>
<tr>
<td>Prepared by:</td>
<td>Thomas Buchan</td>
</tr>
<tr>
<td>Reviewed by:</td>
<td>Steven De Luzuriaga, Nathan Lynch</td>
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Revisions

<table>
<thead>
<tr>
<th>Date</th>
<th>Version</th>
<th>Description</th>
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<tr>
<td>26/10/18</td>
<td>V0.1</td>
<td>Technical Report - Noise Monitoring – OOHW P7: 20 to 21 October 2018</td>
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</table>
1. Overview

Main North and North Shore Corridor Works Project (MNNSCW): Portion 7 - Northern Corridor Works (NCW) are being carried out by Laing O’Rourke Australia Construction Pty Ltd (LOR) on behalf of Transport for New South Wales (TfNSW). LOR has engaged Environmental Resources Management Australia Pty to (ERM) to undertake environmental noise and vibration monitoring during select works.

The monitoring is being undertaken with due regard to, and in accordance with, the NCW – Construction Noise and Vibration Management Plan (CNVMP), last updated March 2018 and other relevant policy, guidelines and standards as listed in the reference section of this report.

This technical report has been prepared to summarise the results and findings of operator attended and unattended noise measurements completed from Saturday, 20 October 2018 to Sunday, 21 October 2018.

The noise monitoring was conducted during Weekend 16 (WE16) track possession works as described in the approved Out-of-Hours Work (OOHW) application form, application number 19 (OOHWAF-019) prepared by LOR for Portion 7 of NCW. The potential for WE16 works to generate noise impacts was identified by LOR during works planning, hence the monitoring was required.

No vibration impacts were identified and hence vibration monitoring was not conducted.

A summary of the works and any complaints is provided in Section 2, with a summary of the resultant noise levels (and any recommendations) provided in Section 3. The noise monitoring methodology is documented in Appendix A, with the detailed noise data set provided in Appendix B.

2. Summary of WE16 Works

Between 20-Oct-18 and 21-Oct-18 WE16 works within the T1 North Shore rail corridor included activities associated with the construction of footings, underline crossing (ULX) construction, standing steel and grouting, overhead wiring (OHW) preparation and cantilever installation at footing locations, and survey works between Brand Street and Albert Avenue Chatswood.

The WE16 works were located within the rail corridor and required no trains running and high voltage power to be isolated. If these works were to occur during standard construction hours then personnel would be at risk of being struck by trains and electrocution.

Deliveries of major components associated with the possession works was limited to standard construction hours.

The plant and equipment listed for use in OOHWAF-019 for all associated activities are reproduced below, and generally aligned with that observed to be in use on site during the works:

- Lighting towers;
- Earth Auger;
- Hi Rail excavators and cranes of varying sizes;
- Concrete pumps and trucks;
- Super Sucker;
- Wacker Packer;
Hydremas (dump truck);
- Vehicles – (light commercial); and
- Welding equipment, impact wrenches and general hand tools.

Further detail of the WE16 work, specified management measures and other mitigation is provided in OOHWAF-019. This OOHWAF also noted that other works were being undertaken by LOR (NCW Portions 1 - 6) and other stakeholders (NRT, Sydney Trains) to utilise the weekend track possession and safe access to the rail corridor. Specifically, it is understood that NRT have been appointed as the principle contractor within area located between Mowbray Road and Albert Avenue. Multiple hi-rail movements and other construction activities were noted within this area during WE16 works, but were not recorded during attended noise measurements undertaken for P7. NRT works were not expected to result in cumulative noise impacts between Hawkins Street and Raleigh Street.

2.1 Summary of Complaints

It is understood that no complaints were received regarding noise during the monitoring period.

3. Monitoring Summary (WE16 Works)

Table 1 presents a summary of the highest measured site noise levels. The full noise data set presenting the measured overall and site Leq, 15minute noise level contributions in dBA is provided in Appendix B (operator attended) and Appendix C (unattended).
Table 1 and 2– Noise Monitoring Summary (attended and unattended)

<table>
<thead>
<tr>
<th>ID</th>
<th>Item</th>
<th>Results</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Operator attended noise measurements were completed at two publically accessible locations adjacent to the rail corridor; refer Figure A1.0 of Appendix A. A total of nine attended noise measurements were conducted. The closest receptors were targeted for monitoring, with actual measurement locations selected based on the position of site works and the potentially most affected receptors. The five highest values (and comparison to the noise management levels (NML) identified in the CNVIS) for attended noise monitoring are presented below in Table 1.1. Refer Appendix B for full noise data set.</td>
<td>The existing noise environment (in the absence of site noise) at the majority of community locations near to the WE16 works was generally dominated by non-project related noise emissions, including those generated by residences near the measurement position, animals (birds and insects and domestic animals), wind-blown vegetation and aircraft passing overhead. Measured site noise level contributions (Leq, 15 minute) were between 54-67 dBA over the two days, depending on the type of construction activity and the duration of noise events that occurred within the sample period. On average1 site noise level contributions for the WE16 works were 21 dBA above the NML, which is to be expected for the type activities being undertaken. A comparison of site noise levels to the predicted values presented in OOHWAF-019 is provided Appendix B of this report. It indicates that on average1, actual emissions associated with WE16 works were 8 dBA above the predicted values in OOHWAF-019. It should be noted that the difference in noise levels is partly related to the implementation of INP penalties for offensive noise characteristics. It is therefore apparent that these INP penalties need to be considered during the OOHW applications and incorporated into predicted noise impacts. While some noise from construction sites is inevitable, the aim of the CNVMP (and other relevant documents presented in the reference section of this report) is to protect the majority of residences and other sensitive land uses from noise pollution most of the time. It focuses on minimising construction noise impacts, rather than only on achieving numeric noise levels. Accordingly, specific recommendations suitable to the WE16 work and the magnitude and extend of impacts observed is provided in Section 3.1 of this report.</td>
</tr>
</tbody>
</table>

Table 1.1 – Attended Site Noise Level Assessment

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Start Time (24 Hr)</th>
<th>Construction Activity at the Time of Measurement</th>
<th>NML vs. Measured Assessment (Leq, 15 minute in dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 012</td>
<td>21-Oct-18</td>
<td>00:00 AM</td>
<td>WE16 Works for Portion 7 of NCW.</td>
<td>Noise Management Level (NML)</td>
</tr>
<tr>
<td>Project 011</td>
<td>20-Oct-18</td>
<td>23:35 PM</td>
<td>WE16 Works for Portion 7 of NCW.</td>
<td>40</td>
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<tr>
<td>Project 008</td>
<td>20-Oct-18</td>
<td>22:30 PM</td>
<td>WE16 Works for Portion 7 of NCW.</td>
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<td>Project 013</td>
<td>21-Oct-18</td>
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<td>WE16 Works for Portion 7 of NCW.</td>
<td>40</td>
</tr>
<tr>
<td>Project 009</td>
<td>20-Oct-18</td>
<td>22:45 PM</td>
<td>WE16 Works for Portion 7 of NCW.</td>
<td>40</td>
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</tbody>
</table>

1. All noise levels are expressed in dBA re 2 x 10^-5 Pa.
2. Measured site noise levels include consideration of INP penalties for offensive noise characteristics.
One unattended noise monitoring device (UNM01) was installed within the rail corridor, adjacent to the proposed work; refer Figure A1.0 of Appendix A.

The five highest values (and comparison to the noise management levels (NML) identified in the CNVIS) are presented below in Table 2.1. Refer Appendix C for full noise data set.

Table 2.1 – Unattended Site Noise Level Assessment

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Start Time (24 Hr)</th>
<th>Construction Activity at the Time of Measurement</th>
<th>Noise Management Level (NML)</th>
<th>Measured Site Noise Level Contribution</th>
<th>Comparison Δ (Meas. – NML.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNM01 (Drake Street Rail Corridor)</td>
<td>21-Oct-18</td>
<td>00:45 AM</td>
<td>WE16 Works for Portion 7 of NCW.</td>
<td>40</td>
<td>75</td>
<td>35</td>
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<tr>
<td></td>
<td>20-Oct-18</td>
<td>22:00 PM</td>
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<td>21-Oct-18</td>
<td>02:00 AM</td>
<td></td>
<td>40</td>
<td>65</td>
<td>25</td>
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<tr>
<td></td>
<td>20-Oct-18</td>
<td>23:45 PM</td>
<td></td>
<td>40</td>
<td>64</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>21-Oct-18</td>
<td>01:00 AM</td>
<td></td>
<td>40</td>
<td>64</td>
<td>24</td>
</tr>
</tbody>
</table>

The existing noise environment (in the absence of site noise) at the majority of community locations near to the WE16 works was generally dominated by non-project related road traffic on public roads and other non-project related emissions included those generated by residences near the measurement position, animals (birds and insects, domestic animals), wind-blown vegetation and aircraft passing overhead. The highest road traffic noise emissions were associated with the Pacific Highway, Elizabeth Street and Drake Street.

Project site noise contributions at UNM01 were dominated by site noise during times of documented activity on site. Estimated site noise level contributions at the nearest receptor (12 Drake Street) varied however L(eq. 15 minute) emissions up to 75 dBA were identified by UNM01 at the nearest receptor.

Estimated site noise level contributions were above the NML’s at UNM01 which is expected for the type of activities being undertaken.

Specific recommendations suitable to the WE16 work and the magnitude and extend of impacts observed is provided in Section 3.1 of this report.

1. All noise levels are expressed in dBA re 2 x 10^-5 Pa.
2. Measured site noise levels include consideration of INP penalties for offensive noise characteristics.

1. The logarithmic average of all measured site noise level contributions was calculated.
3.1 Recommendations

Based on the results and findings of the noise monitoring, it is recommended that:

- **LOR and their sub-contractors** were observed to be utilising the **existing rail corridor noise barriers** to reduce site emissions. Based on measurements conducted during WE16 works and the previous works the existing rail noise barrier is reducing site noise emissions by approximately 10 dBA or more. This measure should therefore be implemented during future OOHW, particularly near the Hopetoun Avenue access/egress point, or for any high noise generating activities.

- Additionally, temporary acoustic fencing was established along the fence line near the Drake Street site entrance, which was observed to reduce site noise emissions by approximately 5 dBA. This measure should continue to be implemented during future OOHW and track possessions.

- **LOR should consider INP penalties for offensive noise characteristics** (i.e. tonal, low frequency and/or impulsive) during the OOHW applications and incorporate penalties into the predicted noise impacts. Based on the comparison of measured site noise levels associated with WE16 works and the predicted values in OOHWF-019, it can be seen that the difference in noise levels is primarily related to the implementation of INP penalties for offensive noise characteristics.

- **LOR should continue to implement the CNVMP** (established with due regard to the CNVIS) during all future NCW activities, importantly during any OOHW that is approved following the appropriate NCW processes. **Noise (and/or vibration) monitoring** should continue to be conducted as per the requirements specified in the construction noise and vibration monitoring program established for NCW.

3.1.1 Closing

These recommendations are based on the findings documented in this report and are designed to reduce noise levels and minimise impacts as far as is considered feasible and reasonable for typical good practice construction management practices.

These noise mitigation, management measures and/or monitoring options have been recommended based on the magnitude and extent of impacts measured and/or observed but a detailed feasibility study has not been conducted. LOR will implement these recommendations where it is considered feasible, reasonable, practical and safe to do so.

Construction noise levels will be reduced and impacts minimised with the successful implementation of the recommendations provided in **Section 3.1** above. Impacts may not be reduced to negligible levels for all receptors during all construction activities; however, the recommendations presented here will ensure that any residual impacts are minimised as far as is practically achievable.

No further recommendations for mitigation and management, to those established by the findings of the noise monitoring, and documented in this report, are provided or warranted. LOR should however remain aware of the potential for nuisance, or an unacceptable level of amenity, to occur due to construction noise and vibration and continue to plan for and then manage the works accordingly.
References

Laing O’Rourke - Sydney Metro City and Southwest - Northern Corridor Works - Construction Noise and Vibration Impact Statement (CNVIS), prepared by ERM and last updated February 2018

Laing O’Rourke - Sydney Metro City and Southwest - Northern Corridor Works - Construction Noise and Vibration Management Plan (CNVMP), prepared by ERM and dated October 2017

Laing O’Rourke - Sydney Metro City and Southwest - Northern Corridor Works - Construction Noise and Vibration Monitoring Program, prepared by ERM and dated October 2017

NSW Environment Protection Authority – NSW Environmental Noise Management – Industrial Noise Policy (INP), January 2000 and relevant application notes

NSW Department of Environment and Climate Change – NSW Interim Construction Noise Guideline (ICNG), July 2009

NSW Government – Sydney Metro Construction Noise and Vibration Strategy (CNVS), August 2017

Standards Australia AS1055–1997™ (AS1055) – Description and Measurement of Environmental Noise, Parts 1, 2 and 3


Appendix A – Noise Monitoring Methodology

A summary of the noise monitoring methodology is provided below. The monitoring was conducted with due regard to an in accordance with the CNVMP and other relevant policy, guidelines and standards as listed in the reference section of this report; and as per the construction noise and vibration monitoring program established for NCW.

1. Overview

Attended noise monitoring

A qualified and suitably experienced operator visited community areas surrounding the NCW works from 20-Oct-18 to 21-Oct-18 and completed operator attended noise measurements at a total of two publicly accessible locations adjacent to the rail corridor; refer Figure A1.0 below. A total of nine noise measurements were conducted. The closest receptors were targeted for monitoring, with actual measurement locations selected based on the position of site works and the potentially most affected receptors.

Overall noise levels (L_{max}, L_{min}, L_{eq}, L_{1}, L_{10} and L_{90} in dBA) were measured at all locations; refer Appendix B. Based on the measured overall values and observations made during each operator attended noise measurement a site L_{eq, 15minute} noise level contribution in dBA was determined in the absence of any influential source not associated with the project.

Unattended noise monitoring

An unattended noise monitoring device (UNM01) was installed within the rail corridor, near the site entrance at Drake Street, Artarmon (Refer Figure A1.0 of Appendix 1) at approximately 14:30 on Saturday, 20 October 2018 and was collected at approximately 17:40 on Sunday, 21 October 2018. Details of the unattended noise monitoring are summarised below:

- Unattended noise monitoring was conducted continuously at one location (UNM01). Refer Figure A1.0 of Appendix A. Overall noise levels (L_{max}, L_{min}, L_{eq}, L_{1}, L_{10} and L_{90} in dBA) were measured in 15 minutes samples;

- The unattended noise monitoring device does not directly measure the site contribution. To estimate potential site noise contributions (in the absence of any influential source not associated with the project) ERM has assumed that any measured L_{eq, 15minute} noise level above 35 dBA at UNM01 is associated with the site, whilst works are known to be in progress. These threshold values were determined based on recent monitoring and observations completed near the site;

- For data recorded at UNM01, the estimated site noise values have been extrapolated to the most affected location (12 Drake Street). This extrapolation was based on the distance from the works on site to the receptor (i.e. approximately 30 metres).

The results of the unattended noise data analysis have been provided in Appendix C.

The five highest values (and comparison to the NML identified in the CNVIS) for attended and unattended monitoring are presented in Table 1.1 and Table 2.1 of this report.
1.1 Monitoring Locations

Figure A1.0 identify the monitoring locations referenced in this report and other items of importance e.g. nearby roads. Each monitoring location is described in Table A1.

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>GPS Co-ordinates (Zone 56H)</th>
<th>Ground Height (AHD), metres</th>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>Attended measurement locations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A01</td>
<td>Outside 13 Raleigh Street, facing west towards works on site.</td>
<td>331725</td>
<td>6257972</td>
</tr>
<tr>
<td>A02</td>
<td>Walkway between Drake and Hawkins Streets, generally facing west towards works on site.</td>
<td>331771</td>
<td>6257870</td>
</tr>
<tr>
<td></td>
<td><strong>Unattended noise monitoring locations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNM01</td>
<td>Within rail corridor near Drake Street site access gate. Approximately 20m southeast from closest sensitive receptor.</td>
<td>331754</td>
<td>6257889</td>
</tr>
</tbody>
</table>

1. AHD = Australian Height Datum not determined during this monitoring event.

2. Technical Requirements

All construction noise monitoring was undertaken in accordance with the “construction noise and vibration monitoring guideline” that is included in Appendix A of the Construction Noise and Vibration Strategy (CNVS) and outlines the minimum requirements for contractors undertaking monitoring on the Sydney Metro Project.

In accordance with the CNVS, both attended and unattended measurements were the focus of all noise monitoring based on the scope of works for P7a. Attended noise monitoring results fed back directly to the project team and actions taken without delay during the works. In accordance with Condition of Approval (CoA) – C11 monitoring data was made available to the construction team and LOR and this report can be provided to the Environmental Representative and/or Acoustics Advisor, the Department of Planning and Environment (DP&E) and the NSW Environment Protection Authority (EPA) if needed.

2.1 Noise Monitoring Equipment

All noise measurements were conducted by suitably experienced and qualified personnel with due regard to, and in accordance with, the relevant local and international standards for environmental monitoring.

The noise measurement instrumentation used to conduct the monitoring complied with the requirements of AS 61672.1 and AS/IEC 60942. Each noise device had current National Association of Testing Authorities, Australia (NATA) calibration certificates, with certification at intervals not exceeding two years at the time of use.
The equipment used for this assessment was as follows:

- 1 x ARL Ngara (Type 1) Environmental Noise Loggers;
- 1 x Brüel & Kjaer 2250 Investigator (Type 1) Sound Analyser; and
- 1 x Brüel & Kjaer 4231 (Type 1) Sound Level Calibrator.

Noise instrument calibration was checked prior to monitoring and again at the conclusion with no difference noted between the two measurements. All data handling and analysis has been completed by a suitably experienced person, and subsequently reviewed by a qualified and experienced acoustician.

2.2 Other requirements

All attended measurements were conducted by appropriately trained personnel in the measurement and assessment of construction noise and vibration. They are familiar with the requirements of the relevant standards and procedures.

The noise measurement procedures employed throughout the monitoring were established in accordance with the requirements of Australian Standard (AS) 1055:1997 Acoustics - Description and Measurement of Environmental Noise.

Attended noise measurements were conducted by an operator using a hand held Type 1 ‘integrating-averaging’ sound level meter. All measurements were completed with the sound level meter mounted to a tripod and with a windscreen fitted, at a height of 1.2 to 1.5 metres above the ground.

Instantaneous noise levels for all noted noise emission sources (extraneous or otherwise), meteorological conditions (average and maximum wind speeds, temperature, precipitation and cloud cover etc.) were recorded during all measurements. Relevant measurement parameters i.e. L_{eq}, L_{min}, L_{max}, L_{1}, L_{10} and L_{90} were recorded in dBA. All noise samples were recorded using the “fast” time response of the sound level meter.

Noise monitoring was not completed within 3.5 metres of any reflective structure or wall, unless behind a barrier. A reduction of up to 2.5 dB was not applied to the measured ambient or site noise contribution (L_{eq}, 15 minute in dBA) as the barrier was reducing noise emissions from site and in general did not increase noise due to the reflective properties of the surface.

Noise monitoring was not completed during periods where wind speeds exceeded 5 m/s at the microphone. Noise monitoring was conducted during rain events however the rain was very light and had no effect on the measured data (if applicable).

The general setup of the sound level meter for attended noise measurements was as per Photo 4.1 of the Construction Noise and Vibration Monitoring Program established for NCW, as reproduced below as Photo A2.1.
Attended noise measurements were undertaken at the potentially most affected receptors identified in the LOR noise assessment (adapted for the phase of works) to confirm that the noise levels in the adjacent community were consistent with the predictions provided by LOR. Other potentially affected receptors were also considered as part of the monitoring regime. Monitoring occurred once works were underway but not at the commencement of activities. The duration of all community noise measurement samples was 15 minutes. The devices microphone was focused on the noise emission centre of the equipment being tested.
Figure A1 - Monitoring Locations
Figure A1.0 – Attended (A01-A02) and Unattended (UNM01) Noise Monitoring Locations
– NCW Portion 7A (WE16 - Saturday, 20 October to Sunday, 21 October 2018)
Appendix B – Recorded Noise Data Set – Operator Attended Noise Monitoring
<table>
<thead>
<tr>
<th>Project</th>
<th>Date</th>
<th>Time</th>
<th>LAeq</th>
<th>LA90</th>
<th>LAeq, 15 minute</th>
<th>NCA</th>
<th>Period</th>
<th>RBL</th>
<th>NML</th>
<th>Comparison</th>
<th>Description</th>
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<td>008</td>
<td>20-Oct-18</td>
<td>22:30</td>
<td>72.04</td>
<td>51.36</td>
<td>61.01</td>
<td>69.62</td>
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<td>56</td>
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<td>59.77</td>
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<td>54.27</td>
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<td>00:00</td>
<td>85.46</td>
<td>58.31</td>
<td>67.19</td>
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<td>69.54</td>
<td>59.4</td>
<td>100</td>
<td>2.9</td>
<td>Site noise</td>
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<td>013</td>
<td>21-Oct-18</td>
<td>00:15</td>
<td>69.17</td>
<td>52.47</td>
<td>58.65</td>
<td>62.62</td>
<td>61.18</td>
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<td>48.64</td>
<td>80</td>
<td>100</td>
<td>Site noise</td>
</tr>
</tbody>
</table>

**Description:**
- Project 008-014 (A01): Measurements taken outside 14 Raleigh Street, facing west towards the works within the rail corridor. NCW P7 works included activities 2-4 (super sucking at footing locations, footings construction and concrete pumping) along with general construction activities, which included the use of a sucker truck, excavators of varying sizes, dump trucks, concrete pumps and trucks, lighting towers and generators, and general hand tools. Passing traffic along Elizabeth street was inaudible during site activities. Nearby wildlife, estimated noise: 52-55 dBA. Site activities outlined above dominated the measurements and contributed to 100% of the measured LAeq noise levels over the seven measurements, with non-project related noise sources generally inaudible throughout the measurement during times of site activity.

- Project 015-016 (A02): Measurements taken within the pedestrian walkway between Drake and Hawkins Streets, facing west towards works within the rail corridor near Drake Street. NCW P7 works involved a number of activities outlined within OOHWA-019, along with general construction activities, which included the use of excavators and hi-rail equipment of varying sizes, dump trucks, access / egress of light commercial vehicles and trucks, and general hand tools. Wind blown vegetation, estimated noise: 45-52 dBA. Passing birds and other wildlife, estimated noise: 50-65 dBA. Site activities outlined above dominated the measurements and contributed to 80% of the measured LAeq noise level over the two measurements with non-project related noise sources generally inaudible throughout the measurement during times of high activity on site.
Appendix C – Recorded Noise Data Set – Unattended Noise Monitoring
Measured Noise Levels
NCW WE16 - UNM01 - Saturday 20 October 2018

Noise Level, dB(A)

Time (24 Hours)
Measured Noise Levels
NCW WE16 - UNM01 - Sunday 21 October 2018

Time (24 Hours)
00:00 02:00 04:00 06:00 08:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 00:00

Noise Level, dB(A)
00 40 80 100

- Excluded (Manual)
- Lmax
- Lmin
- L1
- L90
- Leq
- Estimated Site Noise