WestConnex
Rozelle Interchange

JOHN HOLLAND | CPB CONTRACTORS

JHCPB Joint Venture

Noise and Vibration Monitoring Program

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Contents

Glossary/Abbreviations

Abbreviations	Expanded Text
AA	Acoustics Advisor
ABL	Assessment Background Level
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Attenuation	The reduction in the level of sound or vibration.
AVTG	Assessing Vibration – a technical guideline (DEC 2006)
CS	Communication Strategy
CEMP	Construction Environmental Management Plan
CNVG	Construction Noise and Vibration Guideline (Roads and Maritime 2016)
CNVIS	Construction Noise and Vibration Impact Statement
CoA	Condition of Approval
CSSI	Critical State Significant Infrastructure
dBA	Decibels using the A-weighted scale measured according to the frequency of the human ear.
DEC	Department of Environment and Conservation (now EPA)
DECC	Department of Environment and Climate Change (now EPA)
DECCW	Department of Environment, Climate Change and Water (now EPA)
DPIE	NSW Department of Planning, Industryand Environment
EIS	WestConnex M4-M5 Link Environmental Impact Statement
Environmental aspect	Defined by AS/NZS ISO 14001:2015 as an element of an organisation's activities, products or services that can interact with the environment.
Environmental impact	Defined by AS/NZS ISO 14001:2015 as any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's environmental aspects.
EPA	NSW Environment Protection Authority
EPL	Environment Protection License
ER	Environmental Representative
Feasible and reasonable	Feasible means actions to reduce impacts, and is capable of being put into practice or engineered and practical to build given project constraints. Reasonable means selecting reasonable measures from those that are feasible based on whether the overall benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.
ICNG	Interim Construction Noise Guideline (DECC, 2009)
JHCPB	John Holland CPB Contractors joint venture
$L_{Aeq\ (15min)}$	The A-weighted equivalent continuous (energy average) A-weighted sound pressure level of the construction works under consideration over a 15-minute period and excludes other noise sources such as from industry, road, rail and the community.

Abbreviations	Expanded Text
$L_{A\ (max)}$	the A-weighted maximum noise level only from the construction works under consideration, measured using the fast time weighting on a sound level meter.
NCA	Noise Catchment Areas
NML	Noise management levels
NVMP	Noise and Vibration Management Plan
OEH	Office of Environment and Heritage
OOHW	Out-of-Hours Works – work completed outside of standard construction hours
PPV	Peak Particle Velocity
Project	Design and Construction of Rozelle Interchange Project
RBL	The Rating Background Level for each period is the medium value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period (day, evening and night)
REMMs	Revised Environmental Management Measures
RMS	Root-Mean-Square acceleration
Roads and Maritime	Roads and Maritime Services
SPIR	WestConnex M4-M5 Link Submissions and Preferred Infrastructure Report
Standard construction hours	Hours during which construction work is permitted by the CoA. Further defined in Section 5.1.1 in the NVMP.
TfNSW	Transport for NSW (formerly Roads and Maritime Services)
Works	All physical activities to construct or facilitate the construction of the Project, including environmental management measures and utility works.

1. Introduction

1.1. Context

This Noise and Vibration Monitoring Program (monitoring Program) has been prepared for the Design and Construction of Rozelle Interchange Project (the Project).

This monitoring Program has been prepared to address the requirements of the Minister's Condition of Approval (CoA) C9(c), the WestConnex M4-M5 Link Environmental Impact Statement (EIS) and the revised environmental management measures (REMM) listed in the WestConnex M4-M5 Link Submissions and Preferred Infrastructure Report (SPIR) and all applicable guidance and legislation.

1.2. Background and project description

The WestConnex M4-M5 Link EIS (AECOM 2017) assessed noise and vibration impacts on sensitive receivers and structures during construction and operation of the Project, within Chapter 10 and the Noise and Vibration Technical Working Paper (Appendix J of the EIS).

The EIS identified the potential for noise and vibration impacts during construction which are dependent on the types of construction activity in progress and the proximity of works to sensitive receivers. However, it concluded any potential impacts could be managed by tailored mitigation and management measures, including construction noise and vibration monitoring.

Please refer to Section 1.3 of the Construction Environmental Management Plan (CEMP) for Project description.

1.3. Scope of the monitoring Program

The scope of this monitoring Program is to describe how John Holland CPB Contractors Joint Venture (JHCPB) proposes to carry out noise and vibration monitoring during the construction of the Project. Monitoring will be undertaken for modelling verification at sensitive receivers, to assess compliance in response to complaints, for equipment spot checks, verification of construction traffic and for the verification of acoustic shed effectiveness. For further information refer to Sections 5 and 6.

This Monitoring Program forms part of the Project's Noise and Vibration Management Plan.

Operational noise and vibration monitoring does not fall within the scope of this monitoring Program and therefore is not included within the processes contained within this monitoring Program.

1.4. Environmental management systems overview

The environmental management system overview is described in Section 1.5 of the CEMP.

2. Purpose and objectives

2.1. Purpose

The purpose of this monitoring Program is to describe how JHCPB proposes to conduct noise and vibration monitoring during construction of the Project.

This monitoring Program will apply for the duration of the Project's construction works, unless a longer period is specified by the Secretary of the Department of Planning, Industry and Environment (DPIE).

2.2. Objectives

The key objective of the monitoring Program is to meet the requirements of the CoA's, and ensure all environmental management measures and licence/permit requirements relevant to noise and vibration monitoring are described, scheduled and assigned responsibility as outlined in:

- The EIS prepared for WestConnex M4-M5 Link,
- The SPIR prepared for WestConnex M4-M5 Link,
- Conditions of Approval granted to the Project on 17 April 2018, as modified on 25 February 2019,
- Roads and Maritime specification G36, and
- The Project's Environment Protection Licence (EPL # 21278) issued on 15 May 2020 including the Section 58(5) Licence Variation issued on 18 August 2020.

All relevant legislation and other requirements described in Section 3.1 of this monitoring Program.

3. Environmental requirements

3.1. Relevant legislation

3.1.1. Legislation

All legislation relevant to this monitoring Program is included in Section 3.1.1 of the NVMP.

3.1.2. Guidelines

The main guidelines, specifications and policy documents relevant to this Plan include:

- Roads and Maritime QA Specification G36 – Environmental Protection (Management System).
- Roads and Maritime Construction Noise and Vibration Guidelines (Roads and Maritime 2015)
- NSW Interim Construction Noise Guideline (ICNG), Department of Environment and Climate Change 2009
- NSW Road Noise Policy, Dept. of Environment, Climate Change and Water 2011
- NSW Industrial Noise Policy, Environment Protection Authority 2000
- NSW Assessing Vibration – a technical guideline (AVTG), Department of Environment and Conservation 2006
- Australian Standard 1055 Acoustics – Description and Measurement of Environmental Noise
- AS 2012.1 Acoustics - Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors - Stationary test condition - Determination of compliance with limits for exterior noise
- Australian Standard AS/NZS 2107:2016 Acoustics - Recommended design sound levels and reverberation times for building interiors
- Australian Standard AS 2187.2 Explosives - Storage and use - Part 2 Use of explosives
- Australian Standard AS2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites Australian Standard 2659.1 – 1998 Guide to the use of sound measuring equipment – portable sound level meters
- Australian Standard 2775 Mechanical Mounting of Accelerometers
- Australian Standard 2834-1995 Computer Accommodation, Chapter 2.9 Vibration
- Australian Standard IEC 61672.1 Electroacoustic – Sound Level Meters – Specifications
- British Standard BS 6472-2008, 'Evaluation of human exposure to vibration in buildings (1-80Hz)
- British Standard 7385: Part 2-1993 'Evaluation and measurement of vibration in buildings'
- German Standard DIN4150-3:2016 Vibration in buildings – Part 3: Effects on structures
- ISO 3744 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane
- ISO 3746 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane
- ISO 6393 Earth-moving machinery - Determination of sound power level - Stationary test conditions
- ISO 6395 Earth-moving machinery - Determination of sound power level - Dynamic test conditions.

3.2. Consultation

This monitoring Program has been provided to NSW Health, City of Sydney, City of Canada Bay Council and Inner West Council in accordance with CoA C9 (c) for review and comment. A summary of the consultation undertaken is provided in Section 3.5 of the NVMP.

Community feedback and complaints relating to noise and vibration will be dealt with in accordance with the Noise and Vibration Management Plan (NVMP), Communication Strategy (CS) and the Complaints Management System.

3.3. Environment Protection Licence monitoring requirements

An EPL (# 21278) was issued for the Project on 18 June 2019. Applicable requirements from the EPL have been incorporated into this Program. The first out of hours works, subject to the EPL, shall be completed in a trial period in accordance with the EPL. This is further detailed in Section 5.5.

On 18 August 2020, a Notice of Variation of Licence No. 21278 was issued. This amended condition L4.8 d) i., ii., and iii.to allow working evenings and/or nights. . It is anticipated there will be further numerous variations to the EPL. Furthermore, the EPL would be updated upon completion of the out-of-hours trial period. This Program will only be updated to reflect EPL variations following the scheduled review of the Program.

4. Baseline monitoring data

As part of the EIS process, baseline noise monitoring was conducted between July 2016 and November 2016 at a total of 23 locations. This monitoring was supplemented with monitoring results from a further 11 locations which were monitored during 2014 and 2015 for previous stages of WestConnex. The baseline noise monitoring locations were selected to be representative of the appropriate Noise Catchment Areas (NCAs) within and around the Project, across a mix of existing land uses including residential, commercial, industrial and open space.

For further information regarding baseline noise monitoring refer to Section 4.3 and Annexure G of the NVMP and Section 3 of the EIS Appendix J (Technical Working Paper: Noise and Vibration).

A review of the EIS noise monitoring data by JHCPB found that it potentially did not adequately represent the acoustic environment at some NCAs. Additional monitoring was therefore undertaken by JHCPB and results are summarised in Annexure G of the NVMP.

No further additional baseline monitoring is anticipated, however, if required, it will be undertaken in accordance with the relevant guidance and the NVMP will be updated as necessary and issued to DPIE for approval.

5. Noise monitoring

5.1. Attended and unattended airborne noise monitoring

Attended monitoring of construction noise levels will be undertaken as follows:

- Monitoring will be carried out at the commencement of activities for which a location and activity specific noise and vibration impact assessment has been prepared which identifies that validation monitoring is required (see NVMP Figure 5) to confirm that actual noise and vibration levels are consistent with noise and vibration impact predictions and that the management measures that have been implemented are appropriate,
- At the commencement of activities within an acoustic shed to confirm the actual acoustic performance of the shed is consistent with the predicted acoustic performance,
- Where a change in methodology, plant or equipment is anticipated to result in a significant increase in construction noise impact,
- Where appropriate in response to a noise related complaint(s) (determined on a case-by- case basis) and in accordance with EPL Condition,
- As directed by an authorised officer of the EPA,
- As otherwise required by the CNVIS (refer to NVMP Section 7.2 for information regarding CNVIS, specific monitoring requirements will be identified in the relevant CNVIS as they are location and task specific. Out of Hours Works (OOHW) Protocol (refer Section 5.4) or EPL (refer Section 5.5 and Section 5.5.2),
- Following the implementation of mitigation measures or noise attenuation as a result of exceedance of predicted noise levels, and
- Ongoing spot checks for noise intensive plant and equipment will be undertaken throughout construction to ensure compliance with the maximum noise level goals for construction equipment. Spot checks would be carried out as required on a case-by-case basis, such as in response to a plant/equipment specific noise related complaint and during noise and vibration assessment validation monitoring when it is possible to isolate the noise from one piece of plant or equipment.

Unattended airborne noise monitoring will also be completed, with a noise logger deployed to obtain noise results over longer periods. In these instances, noise loggers will record audio to allow for the identification of construction noise contribution and the presence of any extraneous noise, if privacy concerns can be overcome. The use of unattended airborne noise monitoring is detailed in Section 5.3.

Attended and unattended noise monitoring locations will vary and be determined on a case-by-case basis by a CNVIS, the Project's predictive noise and vibration tool or in response to complaints.

In accordance with the ICNG the duration and amount of noise monitoring will depend on the scale of the construction activities and extent of expected noise impacts. Noise monitoring will cover a representative period of the construction activity. A representative period is the stage of a construction activity where all the plant and equipment operating is consistent with the full range of plant and equipment modelled in the noise and vibration assessment, i.e. noise monitoring is not to be undertaken when the key noise contributing plant and equipment are turned off. The CNVIS identifies the representative periods.

Where possible, monitoring will be undertaken at the most affected noise sensitive receiver's location in proximity to the Project's construction activities. Noise monitoring locations will consider factors including:

- The location of previous monitoring sites,
- The proximity of the receiver to a Project worksite,
- The sensitivity of the receiver to noise,
- Background noise levels and
- The expected duration of the impact.

Monitored noise levels will then be analysed against the predictions made in the relevant CNVIS or using the Project's predictive tools. For where monitored construction noise levels are found to be above modelling predictions are exceeded, refer to Section 9 for further information.

5.1.1. Parameters to be monitored

All environmental noise monitoring will be taken with the following meter settings:

- Time Constant: Fast (i.e. 125 milliseconds),
- Frequency Weightings: A-weighting, and
- Sample period: 15 minutes.

Environmental noise monitoring (excluding spot checks of plant and equipment) will be recorded over 15-minute sample intervals, excluding periods of extraneous noise until a representative sample has been obtained. A representative sample will be determined by operator, who will be competent, suitability trained and experienced in undertaking noise measurements and familiar with the relevant Australian Standards (as detailed in Section 5 of the NVMP). The minimum range of noise metrics to be stored in the memory for later retrieval include the following A-weighted noise levels: L_{A90}, L_{Aeq}, L_{A10}, $L_{A(min)}$and $L_{A\ (max)}$.

For spot checks of noise intensive plant and equipment, duration of monitoring will depend on the source of noise being monitored. Sources of continuous noise (such as generators), measurements will be monitored over one-to-two-minute intervals. For dynamic plant, such as front-end loaders, spot checks will capture a representative activity, such as one truck-and-dog load cycle.

5.2. Attended and unattended ground-borne noise monitoring

Attended monitoring of ground-borne construction noise levels will be undertaken as follows:

- At the first opportunity following the commencement of tunnelling and dive excavation to verify and, if necessary, update the ground-borne noise models,
- Where appropriate in response to a noise related complaint(s) (determined on a case-by- case basis) and in accordance with the EPL, and
- As otherwise required by the CNVIS, OOHW Protocol or EPL.

Monitoring will be undertaken in the most affected habitable room of the residence or other sensitive building and will be conducted in conjunction with vibration measurements whenever practicable (refer to Section 6). The room selected for noise monitoring should be well shielded from airborne noise intrusions, such as road traffic noise to allow the ground-borne noise to dominate over non-construction generated airborne noise.

There may be instances where the resident does not allow access to monitor in the most suitable habitable room. In these instances, JHCPB will endeavour to monitor at the next most suitable available room or location, noting this in the monitoring form.

Given that ground-borne noise is mostly noticed during the evening or at night, noise loggers may also be left in place over night and picked up at a mutually agreed time with the resident. In these instances, noise loggers will record audio to allow for the identification construction noise contribution and the presence of any extraneous noise, if privacy concerns can be overcome. Where the resident or receiver will not allow the noise logger to record audio, attended noise monitoring will be offered instead.

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

5.2.1. Parameters to be monitored

Ground-borne noise monitoring will be taken with the following meter settings:

- Time Constant: Fast (i.e. 125 milliseconds),
- Frequency Weightings: A-weighting, and
- Sample period: 15 minutes.

Ground-borne noise monitoring will be recorded over 15-minute sample intervals, where every 15 minutes the data is to be processed statistically and stored in memory. The minimum range of noise metrics to be stored in the memory for later retrieval include the following A-weighted noise levels: L_{A90}, L_{Aeq}, L_{A1} and $L_{A\ (max)}$.

5.3. Real-time (unattended) noise monitoring

Real-time (unattended) noise monitoring will be undertaken to satisfy CoA C11. The real-time noise monitors will be installed following approval of this monitoring Program.

Real-time noise monitors will be installed near the Lilyfield Rd boundary of the Rozelle civil and tunnel compound towards both the eastern and western end and one monitor near the southern boundary of the Iron Cove site (near the residential boundary), as indicatively identified on Figure 1. The location of the real-time noise monitoring equipment will be subject to the final work site layouts and availability of mains power and will be selected in consultation with the Acoustic Advisor (AA).

The monitor will be installed by a person appropriately trained in the measurement and assessment of construction noise and vibration, who is familiar with the requirements of the relevant standards and procedures and the establishment of real-time monitoring equipment.

The real-time monitoring data will be readily available to JHCPB, Transport for NSW (TfNSW), the Environmental Representative (ER) and AA. The real-time monitoring data will be available to DPIE and EPA on request following an initial screening review, to identify any anomalies or corruption in the dataset.

Where weather may have influenced noise results, the details of inclement weather will be provided in any reporting required.

5.3.1. Parameters to be monitored

Real-time unattended noise monitoring will be taken with the following meter settings:

- Time Constant: Fast (i.e. 125 milliseconds),
- Frequency Weightings: A-weighting, and
- Sample period: 15 minutes.

Real-time noise monitoring will be recorded over 15-minute sample intervals, where every 15 minutes the data is to be processed statistically in real-time and displayed. The minimum range of noise metrics include the following A-weighted noise levels: L_{A90}, L_{Aeq}, L_{A10} and $L_{A\ (max)}$.

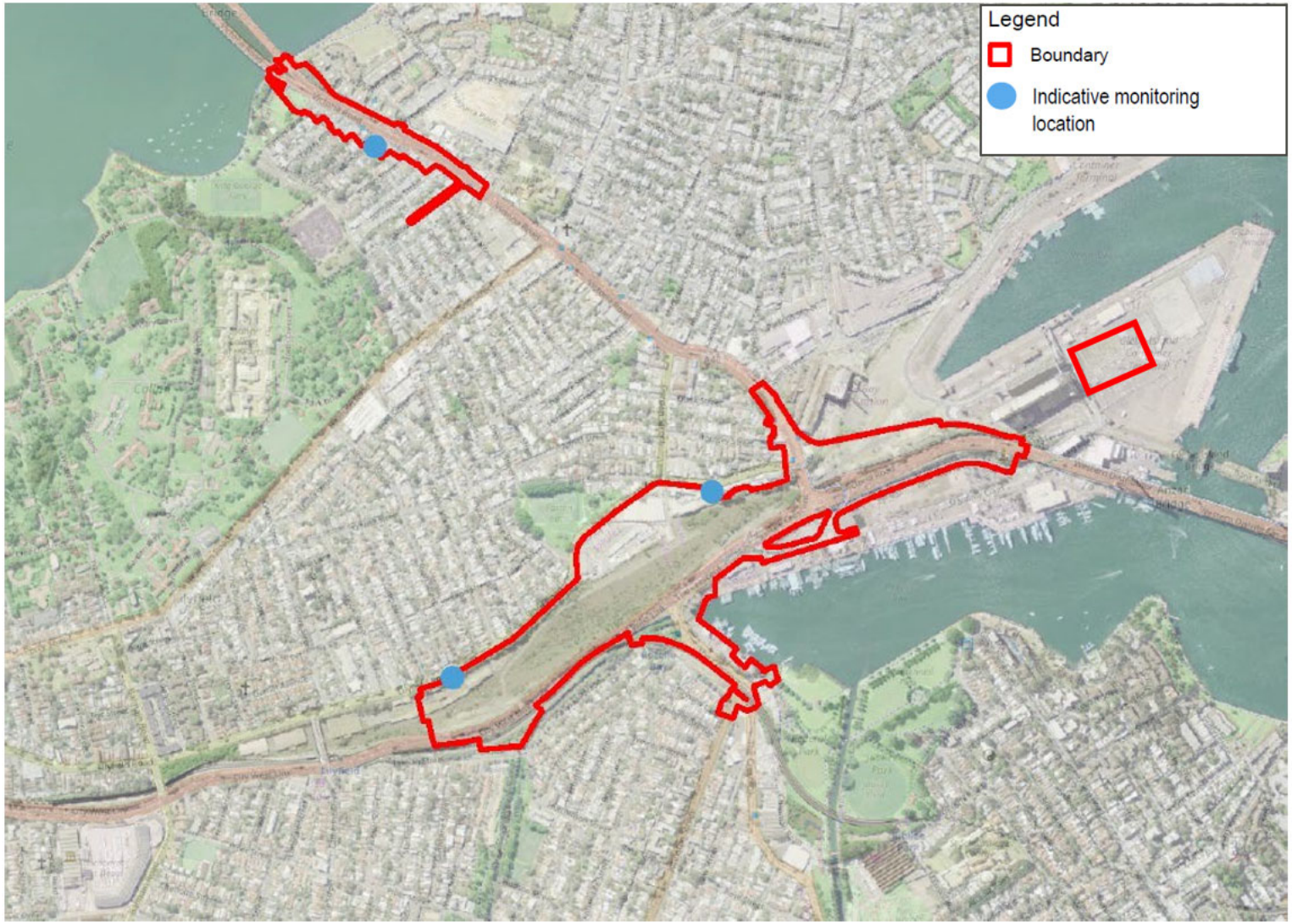

Figure 1 Indicative Real-time noise and vibration monitoring locations

5.4. Out-of-hours Protocol monitoring requirements

The Out-of-Hours Works Protocol enables out-of-hours works (for works that are not subject to an EPL) under certain circumstances and prescribes requirements that must be complied with to undertake the works.

Typically, OOHW that is not subject to an EPL will involve service investigations, relocations and other works items that are not scheduled activities under the *Protection of the Environment Operations Act 1997* (POEO Act) (and associated regulations) and are outside the EPL premise boundary.

In accordance with the Protocol, noise monitoring must be undertaken in accordance with the requirements of the work specific OOHW permit to validate predicted noise impacts. Section 5 of the Out-of-Hours Works Protocol identifies that noise verification monitoring would be undertaken when the impact classification is predicted to be moderately intrusive or highly intrusive (during OOHW period 1) or clearly audible, moderately intrusive or highly intrusive (during OOHW period 2).

5.5. Out-of-hours EPL monitoring requirements

5.5.1. EPL trial period

The EPL enables out-of-hours works (for scheduled activities) under certain circumstances and prescribes requirements that must be complied with to undertake the works.

The out-of-hours works approved under the EPL commences with a four-week trial period. Prior to the commencement of the trial period (14 calendar days), a Construction Noise Impact Assessment must be submitted to the EPA. The Construction Noise Impact Assessment must:

- Describe the proposed out-of-hours works
- Provide predictions of LAeq noise levels at noise sensitive receivers (where noise levels are predicted to be greater than those identified in the EPL)
- Include a monitoring plan to validate the noise predictions, based on monitoring at the boundary of representative sensitive receivers during noise generating activities that are representative of the out-of-hours works.

In accordance with the EPL, noise monitoring must be undertaken throughout the trial period in accordance with the monitoring plan submitted in the Construction Noise Impact Assessment.

At the completion of the four-week trial period, a Validation Report would be submitted to the EPA. In addition, an EPA officer may request a Preliminary Investigation Report (and subsequently a follow-up investigation report) in respect to any noise monitoring undertaken. These reporting requirements are identified in Section 10.

5.5.2. Community agreement monitoring requirements

A validation monitoring plan must be submitted to the EPA for approval as part of the community agreement documentation prior to any OOHW occurring where community agreement has been sought. Validation monitoring must be undertaken for any works that are the subject of a community agreement and must:

- be performed by a suitably qualified and experienced person; and
- be performed on at least the first 2 nights where OOHW will be undertaken.

5.6. Calibration, QA and competency

All monitoring will be undertaken by competent personnel, suitability trained and experienced in undertaking noise measurements.

Noise monitoring equipment used will be at least Type 2 instruments and calibrated in accordance with manufacturer specifications or relevant Australian Standards. The calibration of the monitoring

equipment will be checked in the field before the noise measurement period. Records of monitoring equipment calibration will be maintained by JHCPB throughout the delivery of the Project.

All monitoring records will be retained throughout the delivery of the Project by JHCPB. Noise monitoring records will be completed to record:

- Date and time of measurement,
- Name of person undertaking the measurement,
- Type and model number of monitoring instrumentation,
- Results of field calibration checks,
- Time of day, length of measurement and any measurement time intervals,
- Monitoring location (including a sketched map/photo of area),
- Measurement location details and number of measurements at each location,
- Weather conditions during measurements,
- Operation and activities of the noise sources under investigation,
- Estimated contribution of the Project's activities, and
- Noise due to other extraneous and environmental sources (e.g. traffic, aircraft, trains, dogs barking, insects).

Noise monitoring will be undertaken and recorded in accordance with the relevant noise measurement requirements in the reference standards and documents in Section 3.1.2.

All outdoor noise measurements will be undertaken with a windscreen over the microphone and measurements of noise will be disregarded when it is raining and/or the wind speed is greater than 5 m/s (18 km/h).

Where high background noise levels obscure construction noise contribution during attended noise measurements, operators will either: measure closer to the source and calculate back to the required position, or measure with the source noise off and then on (where possible) and calculate the difference or use the 'pause and cut' feature on the sound level meter to try to exclude as much of the extraneous noise as possible.

Where possible, noise monitoring is to be carried out at least 3.5 m from any reflective surface other than the ground and the preferred microphone/measurement height is 1.2-1.5 m above the ground.

Measurements taken inside buildings should be at least one metre from walls or other reflective surface, and about 1.5 metres from windows, where such instrument siting is possible.

6. Vibration monitoring

6.1. Short term attended and unattended vibration monitoring

Attended vibration monitoring is to be undertaken as follows:

- At the commencement of operation for each plant or activity on site, which has the potential to generate significant vibration levels, where the vibration screening criteria is likely to be exceeded or as determined by a vibration assessment,
- At the commencement of vibration generating activities that have the potential to impact on heritage items to confirm/identify the minimum working distances to prevent cosmetic damage,
- At the first opportunity following the commencement of tunnelling and dive excavation to verify and, if necessary update the ground vibration model,
- Where vibration sensitive locations are determined to fall within the 'minimum working distances' established for each item of plant, so to refine the indicative minimum working distances,
- Where appropriate in response to a vibration related complaint(s) (determined on a case-by-case basis) and in accordance with the EPL,
- As directed by an authorised officer of the EPA, and
- As otherwise required by the CNVIS refer to NVMP Section 7.2 for information regarding CNVIS, however, specific monitoring requirements will be identified in the relevant CNVIS and not prescribed in this Program), OOHW Protocol (Section 6.3) or EPL (i.e. as directed by authorised officer of the EPA).

Vibration monitoring will be undertaken in accordance with the relevant vibration measurement requirements in the reference standards and documents in Section 3.1.2.

Where human comfort is a concern, vibration monitoring results will be assessed and reported against the values set out in Tables 2.2 and 2.4 of the EPA's Assessing Vibration – a technical guideline.

Where property damage is a concern, vibration monitoring results will be assessed and reported against the British Standard 7385, as presented in the NVMP. For heritage structures, BS7385-2:1993 does not provide numerical vibration levels to prevent structural damage. The approach that will be adopted for the Project to assess and manage potential vibration impact on heritage structures is outlined in Section 5.5.3 of the NVMP. Vibration monitoring shall be undertaken in accordance with the vibration measurement requirements stipulated in the reference standards and documents listed above. The following notes of importance are included here:

- Vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant,
- The surface should be solid and rigid to best represent the vibration entering the structure of the building under investigation,
- The vibration sensor or transducer shall not be mounted on loose tiles, loose gravel or other resilient surfaces,
- The vibration sensor or transducer shall be directly mounted to the vibrating surface using either bees wax or a magnetic mounting plate onto a steel washer, plate or bracket which shall be either fastened or glued to the surface of interest, and
- Where a suitable mounting surface is unavailable, then a metal stake of at least 300mm in length shall be driven into solid ground adjacent to the building of interest and the vibration sensor or transducer shall be mounted on that.

Where vibration monitoring is undertaken to measure tactile vibration levels, vibration monitoring results shall be assessed and reported against the acceptable values of human exposure to vibration set out in Tables 2.2 and 2.4 of the EPA's Assessing Vibration – a technical guideline.

The following information shall be recorded:

- Date and time of measurements,
- Name of person undertaking the measurements,
- Type and model number of instrumentation,
- Description of the time aspects of each measurement (i.e. sample times, measurement time intervals and time of day),
- Sketch/photo map of area and measurement location,
- Measurement location details and number of measurements at each location,
- Operation and load conditions of the vibrating plant under investigation, and
- Possible vibration influences from other sources (e.g. domestic vibrations, other mechanical plant, traffic, etc.).

Where attended vibration monitoring is not feasible, due to extended periods of vibration intensive works, an unattended vibration monitoring system will be installed where initial monitoring to establish safe buffer zones is insufficient to ensure goal levels are met, due to changing plant or unknow ground conditions. Unattended monitors will warn plant operators (e.g. via flashing light, SMS, etc.) that vibration is approaching levels where there is potential for cosmetic damage to buildings and structures.

Where unattended vibration monitors are left in place on a private property they will be picked up at a mutually agreed time with the resident.

Monitored vibration levels will be analysed against the predictions made in the relevant CNVIS or using the Project's predictive tools. For where monitored construction noise levels are found to be above modelling predictions or vibration goals are exceeded, refer to Section 9 for further information.

6.1.1. Parameters to be monitored

Vibration data will be processed statistically and stored in memory. The minimum range of vibration metrics to be stored in memory for later retrieval is the following:

- Root-Mean-Square acceleration (RMS), or
- Vector-sum peak-particle velocity (PPV).

All short term attended vibration monitoring will be recorded over a representative sampling interval where the worst-case vibration levels can be captured. Where unattended vibration monitoring is proposed, monitoring will be undertaken continuously whilst the vibrating plant is operational to capture the worst-case vibration levels within the pre-determined 'minimum working distance' from the potentially affected building. Typical 'minimum working distances' for construction equipment are presented in Table A-2 in Appendix A.

6.2. Real-time (unattended) vibration monitoring

Real-time (unattended) vibration monitoring will be undertaken to satisfy CoA C11. The monitors will be installed following approval of this monitoring Program.

Real time vibration monitors will be installed near the Lilyfield Road boundary of the Rozelle Civil and Tunnel compound towards both the eastern and western end, and one monitor near the southern boundary of the Iron Cove Site (near the residential boundary), as indicatively identified on Figure 1. The exact location of the real-time vibration monitoring equipment will be determined in consultation with the AA and be subject to the worksite final layouts, availability of mains power and investigation into suitable conditions. The monitor will be installed by a person appropriately trained in the measurement and assessment of construction noise and vibration, who is familiar with the requirements of the relevant standards and procedures and the establishment of real-time monitoring equipment.

The real-time monitoring data will be readily available to JHCPB, TfNSW, the ER and AA. The real- time monitoring data will be available to DPIE and EPA on request following an initial screening review, to identify any anomalies or corruption in the dataset.

6.2.1. Parameters to be monitored

Real time vibration monitoring will continuously monitor PPV.

6.3. Out-of-hours Protocol monitoring requirements

The Out-of-Hours Works Protocol enables out-of-hours works (for works that are not subject to an EPL) under certain circumstances and prescribes requirements that must be complied with to undertake the works.

Typically, OOHW that is not subject to an EPL will involve service investigations, relocations and other works items that are not scheduled activities under the *Protection of the Environment Operations Act 1997* (POEO Act) (and associated regulations) and are outside the EPL premise boundary.

If vibration intensive activities are proposed as OOHW and have the potential to impact on sensitive receivers or structures, they will be assessed for compliance with minimum working distances as defined in relevant Construction Noise and Vibration Impact Statements (CNVISs) (refer to Section 7.2 of the NVMP) including:

- Cosmetic structural damage impacts,
- Disturbance to building occupants due to vibration.

6.4. Calibration and QA

All monitoring will be undertaken by competent personnel, suitability trained and experienced in undertaking vibration measurements.

All vibration instruments will be calibrated in accordance with manufacturers specifications or relevant Australian Standards. Records of monitoring equipment calibration will be maintained by JHCPB throughout the delivery of the Project.

All monitoring records will be retained throughout the delivery of the Project by JHCPB. Vibration monitoring records will be completed to record:

- Date and time of measurements,
- Name of person undertaking the measurements,
- Calibration dates of monitoring equipment,
- Type and model number of instrumentation,
- Time of day, length of measurement and measurement time intervals,
- Monitoring location (including a sketched map/photo of area),
- Measurement location details and number of measurements at each location,
- Operation and load conditions of the vibrating plant under investigation, and
- Possible vibration influences from other sources (e.g. domestic vibrations, other mechanical plant, traffic etc.).

7. Heritage-listed structures

In accordance with CoA E84, JHCPB will conduct vibration testing before and during vibration generating activities that have the potential to impact on heritage items, to identify minimum working distances to prevent cosmetic damage. Should vibration testing and monitoring show that the preferred values for vibration are likely to be exceeded, JHCPB will follow the process in Section 9.

Heritage items which have the potential to be impacted by vibration are identified in the Non-Aboriginal Heritage Management Plan. Vibration Screening Criteria drawings for vibration intensive ancillary facilities activities have been prepared in accordance with CoA E83 and included in the NVMP (refer to Annexure E of the NVMP) to identify the minimum working distances for heritage buildings during vibration intensive activities. Section 5.5.3 of the NVMP also provides further detail on the approach to managing potential vibration impacts on heritage structures. Vibration Screening Criteria drawings for tunnelling activities are provided in Annexure E of the NVMP.

Vibration assessments prepared for the Project will also identify where monitoring should be conducted at heritage items.

JHCPB will seek the advice of the Project's heritage and noise and vibration specialists, on methods and locations for installing equipment used for vibration, movement and noise monitoring of heritage-listed structures.

8. Heavy vehicle transport noise

In accordance with REMM TT17, JHCPB will track heavy vehicle movements to and from sites and manage truck numbers with the aim of limiting any associated increases in road traffic noise levels during the night-time period to no more than 2 dB(A). The number of heavy vehicles entering and /or exiting will be tracked at the gates of each construction site. Any assumptions regarding the number of heavy vehicle movements to and from the sites will be identified in the CNVIS prepared for each worksite.

Increases in road traffic noise of more than 2 dB(A) during the night-time period will be managed in accordance with the CNVG.

9. Continual improvement and corrective action

Monitored noise and vibration levels will be analysed against the predictions made in the relevant CNVIS or using the Project's predictive tools. Where monitored construction noise levels are found to be above modelling predictions or vibration goals are exceeded, the following actions will be undertaken:

Cease the noise and/or vibration generating activity which causes the exceeded predictions,

- Confirm the monitored levels are not being impacted by other noise or vibration sources,
- Confirm if the exceedance is due to an uncharacteristically loud piece of equipment,
- Identify if the equipment can be swapped out for another piece of equipment or alternative equipment or plant,
- Confirm if the exceedance is due to an uncharacteristically vibratory piece of equipment,
- Confirm that the modelling reflects the actual activity being undertaken,
- Implement other feasible and reasonable measures which may include reducing plant size, modifying time of works, changing operational settings (such as turning off the vibratory function of the machine), and utilising alternative construction methodology or a combination of these,
- Review work practices to ensure compliance with the ICNG,
- Ensure that the learnings from the above are fed back into the noise modelling assessment process for fine-tuning,
- Continue work where impacts can be reduced, and
- Communicate lessons learnt to relevant personnel.

JHCPB will review the work or activity or combination of simultaneous works or activities and where possible, modify the work or activity to prevent any recurrence. Lessons learnt will be communicated to relevant personnel in toolbox talks.

In the case of tunnelling excavation works, where an increased ground-borne noise level has been monitored, a review of the mitigation measures will be undertaken and additional goodwill, alternative accommodation or other more suitable respite offers will be considered, in accordance with the Project's NVMP.

Where a complaint relating to human comfort is received, JHCPB will review the noise and vibration model. If it is determined from the review that there is insufficient local monitoring to validate the noise and vibration model, JHCPB will offer additional monitoring following the process defined in Section 6.1.

10. Reporting of monitoring results

During construction, real time noise and vibration monitoring data will be collected, tabulated and assessed against baseline conditions and performance criteria. Real time noise and vibration monitoring data will be made available to DPIE and EPA, on request, in accordance with CoA C11(d).

Reporting requirements associated with the Program for the construction phase of the Project are presented in Table 1.

Table 1 Reporting requirements

Schedule (during construction)	Requirements	Recipient (relevant authority)
Construction Monitoring Report	Data from real time noise and vibration monitoring will be reported on a six-monthly basis within a Construction Monitoring Report.	AA, DPIE, EPA
EPL Validation Report	The validation report will be submitted to the EPA within 14 calendar days of the completion of the 'trial period' (refer to Section 5.4).	EPA
Preliminary Investigation Report and Follow-Up Investigation Report	Upon request from an EPA officer, the Preliminary Investigation Report will be submitted to the EPA by 4.30pm of the afternoon of the next business day following any noise or vibration monitoring. Where a detected exceedance of a noise goal or limit has occurred a Follow-Up Investigation Report shall be submitted to the EPA within 5 business days (unless otherwise approved by the EPA).	EPA

Separate from the Construction Monitoring Report, Validation Report and Preliminary Investigation Reports, additional records relating to noise and vibration training, toolbox talks, monitoring results and audit results are described in Section 3.11.1 of the CEMP. The complaints management and reporting procedure is described in Section 3.7.4 of the CEMP.