PROJECT MANAGEMENT PLAN

Noise and Vibration Monitoring Program

Sydney Metro West – Western Tunnelling Package

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	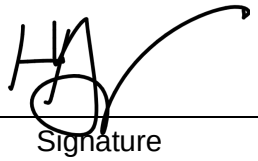	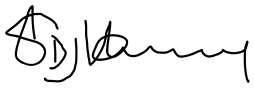
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Table of Contents

Document Details 1
Document Authorisation 1

DOCUMENT CONTROL 3
Revision History 3
Management reviews 3
Controlled copies 3

1 INTRODUCTION 4
1.1 Background 4
1.2 Project location 4
1.3 Purpose 5
1.4 Objectives 5
1.5 Consultation 5
1.6 Endorsement and Approval 6

2 ENVIRONMENTAL REQUIREMENTS 6
2.1 Relevant Legislation and Guidelines 6
2.2 Project Requirements 7
2.3 Environmental Protection Licence 10

3 BASELINE DATA 10

4 GENERAL MONITORING REQUIREMENTS 11
4.1 Calibration, Quality Assurance and Competency 11
4.2 Out of Hours Work (OOHW) 12

5 NOISE MONITORING 12
5.1 Attended Noise Monitoring 12
5.2 Unattended Noise Monitoring 13
5.3 Noise Monitoring Methodology 14
5.4 Ground-Borne Noise 15
5.5 Plant and Equipment Noise Levels 16

6 VIBRATION MONITORING 17
6.1 Attended Vibration Monitoring 17
6.2 Unattended Vibration Monitoring 17
6.3 Vibration Monitoring Methodology 17

7 MONITORING AND ACTION PROCESS 19

8 TARGET MONITORING LOCATIONS 20

9 NOISE AND VIBRATION REPORTING 21

ATTACHMENTS 23
Attachment 1 – Consultation 23

DOCUMENT CONTROL

The current document version number and date of revision are shown in the document footer. All changes made to the Management Plan during its implementation on a live project are to be recorded in the amendment tables below.

Revision History

Revision	Date	Description of changes	Prepared by	Approved by
A	31 January 2022	First Draft	Steven Luzuriaga (SLR Consulting)	Simon Hussey
B	04 April 2022	Addressing Stakeholder Comments	Steven Luzuriaga (SLR Consulting)	Simon Hussey
C	12 May 2022	Addressing Stakeholder Comments	Steven Luzuriaga (SLR Consulting)	Simon Hussey

Management reviews

Review date	Details	Reviewed by

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Name	Position	Date	Revision

1 INTRODUCTION

1.1 Background

Sydney Metro West (SMW) is a new underground railway connecting Greater Parramatta and the Sydney CBD. It will provide fast connections between greater Sydney's two major business centres as well as providing better access to the growing business and entertainment precincts in Olympic Park and Pyrmont, the health and medical research hub at Westmead and the future business and tourism site at The Bays.

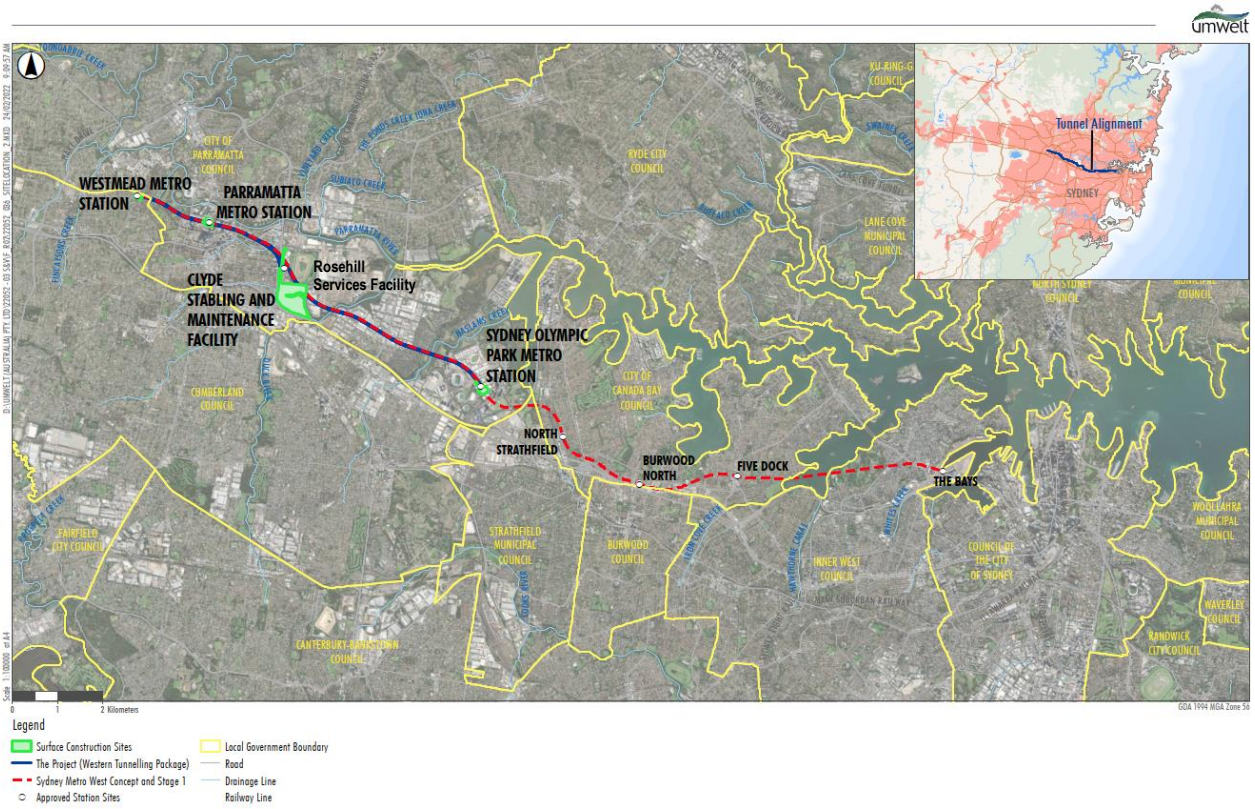
An Environmental Impact Statement (EIS) (Jacobs/Arcadis, 2020) for the Concept and Stage 1 assessed the noise and vibration impacts in response to the Secretary Environmental Assessment Requirements issued by the Department of Planning, Industry and Environment (DPIE). The Project was approved on 11 March 2021 (SSI 10038).

Sydney Metro is delivering the Sydney Metro West project via several different packages, including the Western Tunnelling Package (WTP, the Project).

1.2 Project location

The entire Sydney Metro West Stage 1 is shown in Figure 1 below. The WTP Project location is from Westmead to Sydney Olympic Park.

Figure 1: Project Location



1.3 Purpose

This noise and vibration monitoring program (NVMoP) outlines the Gamuda Australia and Laing O'Rourke Consortium (GALC) propose to undertake noise and vibration monitoring during construction of the WTP. This document should be read in conjunction with the WTP Construction Noise and Vibration Management Plan (CNVMP). This NVMoP has been developed to comply with Condition of Approval (CoA) C14 – construction monitoring programs. This condition is outlined in Section 2.2.

1.4 Objectives

The objective of this NVMoP is to define, address and implement noise and vibration monitoring requirements and will apply for the duration of construction.

This NVMoP outlines how GALC will comply with and implement the applicable elements of the following documents, collectively referred to herein as the 'Project requirements' for the WTP:

- The CoA (issued on 11 March 2021 and as modified on 28 July 2021)
- The Project EIS, Submissions Report and Amendment Report
- Sydney Metro Construction Environmental Management Framework (CEMF).

The objectives and targets applicable to the Noise and Vibration Management on the Project are outlined in the CNVMP. In addition, the following objectives specifically related to the implementation of the monitoring program will be adopted from the Sydney Metro Construction Noise and Vibration Standard (CNVS):

- Ongoing noise monitoring during construction at sensitive receivers during critical periods (i.e. times when noise emissions are expected to be at their highest - e.g. piling and hammering) to identify and assist in managing high risk noise events
- Monitoring will be undertaken inform the relevant personnel when the noise or vibration goal has been exceeded so that additional management measures may be implemented
- Regular compliance checks on the noise emissions of all plant and machinery used for the project to:
    - indicate whether noise emissions from plant items were higher than predicted
    - identify defective silencing equipment on the items of plant
    - assist in determining where additional management measures should be implemented.

1.5 Consultation

In accordance with CoA C14(a), this NVMoP will be prepared in consultation with the Environment Protection Authority (EPA), Sydney Olympic Park Authority (SOPA), Parramatta City Council (PCC) and Cumberland City Council (CCC). The details of all information requested by these stakeholders through consultation will be included in the final NVMoP, including copies of all correspondence from those agencies, refer Attachment 1.

GALC will also facilitate active community consultation and engagement to maintain positive and cooperative relationships with schools, local residents, building owners and occupiers and other members of the community (e.g. Sydney Trains, Parramatta Light Rail and Rosehill Gardens Racecourse) to assist in alleviating concerns and minimising disturbance. Relationships will also facilitate collaboration with regard to OOHW programming and provision of respite as required.

The Project Community Communication Strategy (CCS) details the approach to stakeholder and community engagement in accordance with the Sydney Metro Overarching Community

Consultation Strategy. Specific to noise and vibration management, consultation will include periodic notification of work activities and progress and specific notification to potentially impacted community prior to especially noisy activities.

1.6 Endorsement and Approval

In accordance with CoA C18 – CoA 20 this NVMoP will be submitted to the Planning Secretary for approval at least one month before commencement of construction, following endorsement by the Environmental Representative (ER) and the Acoustics Advisor (AA). Construction must not commence until the Planning Secretary has approved the NVMoP (CoA 21).

2 ENVIRONMENTAL REQUIREMENTS

2.1 Relevant Legislation and Guidelines

Legislation relevant to this monitoring program includes:

- Protection of the Environment Operations Act 1997 (POEO Act)

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

- Sydney Metro Construction Noise and Vibration Standard (CNVS) 2020 v4.3
- Sydney Metro Construction Environmental Management Framework (CEMF) 2020 v4.1
- 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 Noise Policy for Industry, Environment Protection Authority 2017
- NSW Assessing Vibration – a technical guideline (AVTG), Department of Environment and Conservation 2006
- Australian Standard 1055:2018 Acoustics – Description and Measurement of Environmental Noise
- Australian Standard AS/NZS 2107:2016 Acoustics - Recommended design sound levels and reverberation times for building interiors
- Australian Standard AS2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites
- Australian Standard 2659.1 – 1988 Guide to the use of sound measuring equipment – portable sound level meters1
- Australian Standard 2775-2004 Mechanical Mounting of Accelerometers
- Australian Standard IEC 61672.1 Electroacoustic – Sound Level Meters – Specifications
- British Standard 7385:1993 Evaluation and measurement of vibration in buildings – Part 2 Guide to damage from ground-borne vibration German Standard DIN4150-3:2016 Vibration in buildings – Part 3: Effects on structures
- ISO 3744:2010 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 3746:2010 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

2.2 Project Requirements

The Project requirements relevant to the preparation of this NVMoP are identified in Table 1. A document reference is also included to indicate where the requirement is addressed in this NVMoP or other documents. Additional construction noise and vibration project requirements are outlined in the CNVMP.

Table 1: NVMoP Compliance Matrix

ID	Conditions of Approval	Document Reference
C14	The following Construction Monitoring Programs must be prepared in consultation with the relevant government agencies identified for each to compare actual performance of construction of Stage 1 of the CSSI against the performance predicted in the documents listed in Condition A1 of this schedule or in the CEMP: a) Noise and vibration Monitoring program; consult with EPA, SOPA (in respect of Sydney Olympic Park), Place Management NSW (in respect of The Bays) and Relevant Council(s)	This Document Section 1.5 Attachment 1
C15	Each Construction Monitoring Program must provide: a) details of baseline data available including the period of baseline monitoring; b) details of baseline data to be obtained and when; c) details of all monitoring of the project to be undertaken; d) the parameters of the project to be monitored; e) the frequency of monitoring to be undertaken; f) the location of monitoring; g) the reporting of monitoring results and analysis results against relevant criteria; h) details of the methods that will be used to analyse the monitoring data; i) procedures to identify and implement additional mitigation measures where the results of the monitoring indicated unacceptable project impacts; j) a consideration of SMART principles; and k) any consultation to be undertaken in relation to the monitoring programs; and l) any specific requirements as required by Conditions C16 to C17 of this schedule.	a) Section 3 b) Section 3 c) Section 4,5,6 d) Section 5,6 e) Section 4,5,6 f) Section 4,5,6 g) Section 8 h) Section 4 i) Section 7 j) Section 7 k) Section 1.5 l) Section 2.2
C16	The Noise and Vibration Construction Monitoring Program and Blasting Construction Monitoring Program must include: a) noise and vibration monitoring determined in consultation with the AA to confirm the best-achievable construction noise and vibration levels with consideration of all reasonable and feasible mitigation and management measures that will be implemented; b) for the purposes of (a), noise monitoring must be undertaken during the day, evening and night-time periods and within the first month of work as well as throughout the construction period and cover the range of activities being undertaken at the sites; and c) a process to undertake real time noise and vibration monitoring. The results of the monitoring must be readily available to the construction team, the Proponent, ER and AA. The Planning Secretary and EPA must be provided with access to the results on request.	Note: blasting not currently proposed a) Section 4 b) Section 4 c) Section 4
C18	With the exception of any Construction Monitoring Programs expressly nominated by the Planning Secretary to be endorsed by the ER, all Construction Monitoring Programs must be submitted to the Planning Secretary for approval.	Section 1.6
C19	The Construction Monitoring Programs not requiring the Planning Secretary's approval must obtain the endorsement of the ER as being in accordance with the conditions of approval and all undertakings made in the documents listed in Condition A1 of this schedule. Any of these Construction Monitoring Programs must be submitted to the ER for endorsement at least one (1) month before the	Section 1.6

ID	Conditions of Approval	Document Reference
	commencement of construction or where construction is phased no later than one (1) month before the commencement of that phase.	
C20	Any of the Construction Monitoring Programs which require Planning Secretary approval must be endorsed by the ER and then submitted to the Planning Secretary for approval at least one (1) month before the commencement of construction or where construction is phased no later than one (1) month before the commencement of that phase.	Section 1.6
C21	Unless otherwise agreed with the Planning Secretary, construction must not commence until the Planning Secretary has approved, or the ER has endorsed (whichever is applicable), all of the required Construction Monitoring Programs and all relevant baseline data for the specific construction activity has been collected.	Section 1.6
C22	The Construction Monitoring Programs, as approved by the Planning Secretary or the ER has endorsed (whichever is applicable), including any minor amendments approved by the ER, must be implemented for the duration of construction and for any longer period set out in the monitoring program or specified by the Planning Secretary or the ER (whichever is applicable), whichever is the greater.	Section 4
C23	The results of the Construction Monitoring Programs must be submitted to the Planning Secretary, ER and relevant regulatory agencies, for information in the form of a Construction Monitoring Report at the frequency identified in the relevant Construction Monitoring Program.	Section 8

Requirements of the Construction Environmental Management Framework (CEMF), Revised Environmental Mitigation Measures (REMMs) and CNVS relevant to this NVMoP are identified in Table 2. A document reference is also included to indicate where the requirement is addressed in this NVMoP or other documents.

Table 2: CEMF, REMM and CNVS Requirements

Requirement	Conditions	Document Reference
CEMF 3.14	a) Issue specific environmental monitoring will be undertaken as required or as additionally required by any approval, permit or licence conditions. b) The results of any monitoring undertaken as a requirement of a licence or permit that is required to be published will be published on the Principal Contractor's, or a project specific, website within 14 days of obtaining the results.	a) This Document b) Section 8
CEMF 3.16	a) Principal Contractors will maintain appropriate records of the following: i. Site inspections, audits, monitoring, reviews or remedial actions; ii. Documentation as required by performance conditions, approvals, licences and legislation; iii. Modifications to site environmental documentation (eg CEMP, sub-plans and procedures); and iv. Other records as required by this Construction Environmental Management Framework. b) Records must be accessible onsite for the duration of works. c) Additionally records will be retained by the Principal Contractor for a period of no less than 7 years. Records will be made available in a timely manner to Sydney Metro (or their representative) upon request.	a) This Document b) Section 8 c) Section 8

Requirement	Conditions	Document Reference
CEMF 8.2	c) Noise and vibration monitoring would be undertaken for construction as specified in the CNVS. d) The following compliance records would be kept by Principal Contractors: i. Records of noise and vibration monitoring results against appropriate NMLs and vibration criteria; and ii. Records of community enquiries and complaints, and the Contractor's response.	c) Section 4,5,6 d) Section 8
REMM NV16	Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure (in consultation with a structural engineer) and vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure. For heritage items, the more detailed assessment would specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.	Section 6
REMM NV20	Undertake consultation with the Rosehill Gardens Racecourse and an equine veterinary expert to inform construction noise and vibration objectives for this sensitive receiver. Achievement of objectives are to be demonstrated in accordance with Noise and Vibration Construction Monitoring Program required by Conditions C15 and C16 and would include reference to equine behavioural responses where feasible.	Section 5 and 6
CNVS 6.1	**Plant Noise Auditing, Compliance Evaluation and Reporting** • Noise audits to compare sound power level against values in Section 4.3 of CNVS • For all measurements, the plant or equipment under test would be measured while operating under typical operating conditions • In the case of an exceedance in Sound Power Levels the item of plant would either be replaced, or the advice of an acoustic consultant would be sought to provide suitable mitigation measures.	Section 5.5
CNVS 6.2	**Noise Monitoring** • Noise monitoring where noise goals predicted to be exceeded • All noise monitoring results would be assessed against the nominated noise goals and compiled into a report to be forwarded to the construction contractor and project manager. • Reporting would be submitted to the construction contractor and project manager within one week of being undertaken or at weekly intervals for continuous monitoring. • All noise monitoring reports would also be made available to the public through a publicly accessible website.	Section 4,5
CNVS 6.3	**Vibration Monitoring** • Vibration monitoring where exceedance of cosmetic damage criteria expected, or where human response exceedance is expected and where concerns raised. • All vibration monitoring results would be assessed against the nominated vibration goals and compiled into a report to be forwarded to the construction contractor and project manager. • Reporting would be submitted to the construction contractor and project manager within one week of being undertaken or at weekly intervals for continuous monitoring. • All vibration monitoring reports would also be made available to the public through the publicly accessible website.	Section 4,6

2.3 Environmental Protection Licence

An Environmental Protection Licence (EPL) will be required for the WTP. Once EPL conditions relevant to noise and vibration have been finalised, a review of this NVMoP will be undertaken and the document updated as required. The NVMoP will be updated as per the process described in the Construction Environmental Management Plan (CEMP).

3 BASELINE DATA

The existing noise environment was quantified (via measurement) at representative NCAs surrounding the Project site during preparation of the EIS. A summary of the measured ambient and background noise levels (RBLs) are presented in Table 3 below. Individual sensitive receiver locations are identified in Technical Paper 2 of the EIS. NCA locations are outlined in the CNVMP.

Measured noise levels in the vicinity of the Project generally display a diurnal trend with lower levels during the night-time than the daytime and evening periods. This is characteristic of urban and suburban areas, where the ambient noise environment is primarily influenced by road traffic.

Baseline data from the EIS has been reviewed and is representative of ambient noise in the Project area. No further baseline monitoring is proposed prior to commencement of construction of the WTP.

Table 3 Summary of Ambient and Background Noise Levels

Location ID	NCA	RBL (dBA)			Average Noise Level (dBA)		
		Day	Evening	Night	Day	Evening	Night
B.02	NCA01	48	46	41	58	53	51
B.01	NCA02	49	47	37	67	67	62
B.03	NCA03	58	53	43	69	67	62
B.04	NCA04	51	48	41	61	58	57
B.05	NCA05	50	49	45	56	55	53
B.06	NCA06	52	51	44	58	57	55
B.07	NCA07	46	44	41	60	57	55
B.08	NCA08	48	48	46	55	54	52
B.09	NCA09	48	46	41	57	58	53

Note: The assessment periods are the daytime which is 7 am to 6 pm Monday to Saturday and 8 am to 6 pm on Sundays and public holidays, the evening which is 6 pm to 10 pm, and the night-time which is 10 pm to 7 am on Monday to Saturday and 10 pm to 8 am on Sunday and public holidays. Refer the NSW EPA Noise Policy for Industry.

4 GENERAL MONITORING REQUIREMENTS

Monitoring for the Project will be implemented at the commencement of works and at regular intervals throughout the Project (i.e. during the day, evening and night-time periods, within the first month of work and throughout the construction period to cover a range of activities being undertaken on site) to quantify the airborne noise, ground-borne noise and vibration levels associated with construction activities. Monitoring will also be required in the event of a complaint being received or during OOHW where the AMM has identified monitoring.

Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals (as is the case for select project works), noise or vibration monitoring may be conducted at the affected receiver(s) or a nominated representative location (typically the nearest receiver where more than one has been identified). Monitoring can be in the form of either unattended logging or operator attended surveys. The purpose of monitoring is to inform the relevant personnel when the noise or vibration goal is being approached so that work methodology or equipment being used can be altered, and / or additional management measures may be implemented. Noise and vibration management levels and screening levels are presented in Section 6 of the CNVMP.

This Construction Monitoring Program, as outlined in CoA C22 must be implemented for the duration of construction and for any longer period set out in the monitoring program or specified by the Planning Secretary, whichever is the greater.

All construction noise and vibration monitoring will be undertaken generally in accordance Section 6 of the CNVS. This outlines the minimum requirements for contractors undertaking monitoring on the Sydney Metro Project. Noise and vibration monitoring requirements will be determined in consultation with the AA to confirm the best-achievable construction noise and vibration levels with consideration of all reasonable and feasible mitigation and management measures that will be implemented.

In accordance with CoA C16 real-time noise and vibration monitoring will be the focus of monitoring. Vibration monitoring devices will be installed at sensitive buildings within safe working distances of vibration generating activities. Real-time noise monitoring will be undertaken at locations representative of the nearest and potentially most affect receivers.

As per CoA C16 real time monitoring data will be readily available to the construction team, Sydney Metro, the ER and the AA. Monitoring data will also be made available to the Planning Secretary and EPA on request. Unattended monitoring will continuously measure noise or vibration levels for the duration of the monitoring period, except during device maintenance or down time. Further detail on noise and vibration requirements are outlined below.

4.1 Calibration, Quality Assurance and Competency

All attended measurements will be conducted by appropriately trained personnel in the measurement and assessment of construction noise and vibration. They will be familiar with the requirements of the relevant standards and procedures. Specific targeted training will be developed by the Environmental Manager to ensure that environmental monitoring officers are appropriately trained. Refer to the CEMP for full details on environmental training.

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

Attended noise monitoring would be completed using at minimum Class 2 instruments, as per Australian Standard IEC 61672.1.

4.2 Out of Hours Work (OOHW)

Where out-of-hours works (OOHW) are undertaken, noise and vibration monitoring including a visual inspection of the activities may be undertaken as identified by the OOHW Permit, including to:

- Ensure noise and vibration mitigation measures specified in the approved application are appropriately implemented
- Verify assumptions and model outcomes of the OOHW works (i.e. predicted noise levels)
- Any necessary additional measures are identified and implemented where reasonable and feasible.

Where OOHW monitoring is required, this will be conducted as soon as practicable (e.g. preferably first night) during the approved works and would involve attended monitoring as described in Section 5 and Section 6.

Personnel carrying out monitoring will consider the actual vs proposed equipment in use and confirm proposed physical mitigation measures (such as noise shielding and enclosures) are being implemented in accordance with the OOHW Permit.

Monitoring results will be compared with predicted levels to establish the accuracy of predicted noise and inform future predictions. Where the need for additional controls is identified, these will be implemented as soon as possible as actions undertaken in response to monitoring results.

5 NOISE MONITORING

5.1 Attended Noise Monitoring

Attended noise measurements will be undertaken at the closest and potentially most affected receivers (for each scenario) identified in the DNVIS from the commencement of construction activities to confirm that the noise levels in the adjacent community are consistent with the predictions the DNVIS. Other potentially affected receivers will also be considered as part of the monitoring regime depending on the phase of works.

Noise monitoring will be undertaken on all work phases as detailed in Table 4. Monitoring for the Project will be required at the commencement of works and throughout the Project (i.e. when new construction activities commence) to quantify the airborne noise, ground borne noise and vibration levels associated with construction activities. Monitoring would also be required in the event of a complaint being received and would be conducted at the most affected receiver in accordance with the CNVS, refer Project Community Communication Strategy (CCS). Where required, consultation with the community will also include arranging access to private property to install monitoring equipment.

Where OOHW is approved and monitoring is determined to be required, attended noise measurements will be conducted at the most affected receivers following the general requirements specified in Section 4 and the methodology outlined in Section 5.3. Refer Section 8 for target monitoring locations at each construction site.

5.2 Unattended Noise Monitoring

In accordance with CoA C16 real-time noise monitoring will be undertaken throughout the project at the most affected receiver locations or at representative locations where site noise level contributions at the nearest sensitive receivers can be monitored.

GALC will utilise SiteHive real-time environmental management technology across the Project, capturing data 24/7 at each project site. This includes the use of the innovative SiteHive Hexanode monitoring device, along with all Project noise, dust and vibration data captured for analysis and reporting in the SiteHive platform. The benefits of this include:

- Proactive real-time environmental management ensures potential issues are addressed before they occur, allowing streamlined operations and significant reduction in manual work
- Project teams can access live environmental data from site, wherever they are, allow quick confident decisions to be made, informed by rich data
- Network of SiteHive data across metropolitan areas, including data from EPA & BoM stations, allows trends to be analysed to determine site activity vs ambient conditions
- Transparency and collaboration with stakeholders greatly increased through real-time data sharing, creating a much more productive and positive delivery environment.

The SiteHive Hexanode sound level meter has been rigorously tested by the National Measurement Institute (NMI), the division of the Australian Federal Government Department of Industry, Science, Energy & Resources responsible for providing world-class measurement services to support a fair, safe, healthy and competitive Australia. The NMI's acoustic, ultrasound and vibration measurement services are the most accurate in Australia, and include providing the certification for NATA (National Association of Testing Authorities) testing facilities, who provide class certification for noise meters. Working with SiteHive, NMI undertook all of the possible tests outlined in IEC 61672-2, with the Hexanode passing all precision requirements within the criteria of a class 2 device. Calibration certificates will provided for each device upon deployment.

SiteHive provides real-time environmental management technology, which will foster a transparent and collaborative project delivery environment. All environmental data will be available in one platform, allowing the project team to make quick and confident evidence based decisions, and minimise impact on stakeholders. SiteHive automates tasks which were previously laborious, including environmental data collection, analysis and reporting, freeing up project resources to focus on pro-actively managing works.

Thresholds will be set on the SiteHive monitoring devices that will trigger camera and audio recordings to verify the source and direction of the noise. This feature, along with observations from attended noise measurements, will be used to support and interpret the unattended noise data and identify noise impacts during construction.

Unattended monitoring will consist of at least one permanent monitor per site for the entirety of the Project. Additional SiteHives will be utilised depending on the programming of construction activities, identified risks of work being undertaken and for complaints investigations at various stages of the Project. Refer Section 8 for target monitoring locations at each construction site.

5.3 Noise Monitoring Methodology

Attended noise measurements will be conducted by an operator using a handheld Type 1 or Type 2 'integrating-averaging' sound level meter, following the guidelines of *Standards Australia AS1055:2018 – Description and Measurement of Environmental Noise*.

A calibration level check will be conducted prior to and after all measurement rounds. Measurements will be completed with the sound level meter mounted to a tripod (if possible) at 1.2 - 1.5 m above the ground and with a windscreen fitted.

Instantaneous noise levels for all significant noise sources, as well as any audible construction activities, meteorological conditions (average and maximum wind speeds, temperature, precipitation and cloud cover etc.) shall be recorded during all measurements. The location of monitoring, time of measurement, the equipment working/construction activities, the setback distances and all relevant measurement parameters (i.e. L_{Aeq}, L_{Amin}, L_{Amax}, L_{A1}, L_{A10} and L_{A90}) should also be recorded.

The duration of each community noise measurement sample will be 15 minutes. The site noise level contribution $L_{Aeq(15minute)}$ and L_{Amax} shall be determined in the absence of any influential source not associated with the Project for direct comparison to the relevant criteria.

Noise monitoring will be completed in the free-field (i.e. not within 3 m of any reflective structure or wall, if possible). Where it is not possible to measure more than 3 m from any reflective structure or wall, a reduction of up to 2.5 dB will be applied to the measured ambient and site noise contribution ($L_{Aeq(15\ minutes)}$) to account for the likely increase in noise associated with reflective surfaces.

Noise monitoring will be carefully reviewed during periods where wind speeds exceed 5 m/s at the microphone or during any rain events. Where wind and/or rain adversely affects the noise measurement, attended monitoring would cease and unattended noise monitoring data would be flagged accordingly and excluded from analysis.

Monitoring will be conducted as per the requirements of this NVMoP and with due regard to AS1055; AS61672, AS1259 (or similar) and IEC60942; as relevant to the monitoring being conducted as well as *AS 2659.1-1998 Guide to the use of sound measuring equipment – portable sound level meters*, or any revisions of that standard which may be made by Standards Australia.

All noise samples shall be recorded using the "fast" time response of the sound level meter. Corresponding field notes shall be made for each noise or vibration survey, and the records kept on file.

If monitoring identifies that predicted noise levels are being exceeded, GALC will review construction practices/sequencing and mitigation measures etc. in order to reduce noise levels, minimise impacts and to enable provision of information on noise levels to surrounding and potentially affected residents should this be required (i.e. on request or following a complaint).

For each monitoring event, the following information will be recorded:

- Date and time of measurements,
- Name of person undertaking the measurements,
- Type and model number of instruments
- Sample times, measurement time intervals and time of day
- Map of area showing measurement location, source location and sensitive receivers
- Measurement location details and number of measurements at each location
- Construction activities and conditions of the equipment under investigation

All noise monitoring results would be assessed against the nominated noise goals and compiled into a report to be forwarded to the construction contractor and project manager. Reporting would be submitted to the construction contractor and project manager within one week of being undertaken or at weekly intervals for continuous monitoring. All noise monitoring reports would also be made available to the public through a publicly accessible website.

Provisions, Safeguards and Monitoring Contingencies (Concurrent Works)

The purpose of this monitoring contingency is consistent with that of the overall NVMoP: it will inform the relevant personnel if the noise management levels are being approached (or exceeded) so that the work methodology or equipment being used can be altered, and / or additional management measures may be implemented. This will assist to reduce emissions and avoid/minimise any impacts (or future increase in impact to those addressed by this NVMoP) so that the surrounding community and broader acoustics environment are safeguarded against further nuisance, or temporary reduction in amenity.

As recommended by the DNVIS and addressed as commitments in the CNVMP, noise monitoring will occur as per the requirements and specification presented in this NVMoP.

This monitoring will already occur for specific WTP construction activities that are likely to exceed the relevant noise management levels, as per the AMM requirements, and in the form of either unattended monitoring or operator attended measurements.

All monitoring will enable the site noise level to be established in the absence of any influential source not associated with the WTP Project, and comparison to the predicted values of relevant DNVIS and criteria presented in the CNVMP. Monitoring will consider all WTP work occurring at the time “i.e. concurrent works” so that the overall site noise level contribution is established before further evaluation. Should circumstances arise during the works that the potential for increased air-borne noise emissions is identified, or valid complaints are received on this regard; additional noise monitoring will occur.

5.4 Ground-Borne Noise

The highest levels of ground-borne noise are expected to occur due to construction activities involving TBMs, hydraulic hammers / rock breakers and road headers. Where ground-borne noise generating activities are identified to occur within the safe working distances or where impacts at receivers are predicted in the DNVIS, noise monitoring in the community will be undertaken to verify the noise level contribution from ground-borne noise generating activities.

Ground-borne noise 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.

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_{Amax}.

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.

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, GALC will endeavour to monitor at the next most suitable available room or location, noting this in the monitoring form.

Where permitted, noise loggers will record audio to allow for identification of the construction noise contribution and the presence of any extraneous noise provided 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 where appropriate.

Measurements will be carried out by an appropriately trained and competent person in the measurement and assessment of construction noise and vibration.

Where ground-borne noise monitoring is not possible / permitted, estimates of ground-borne noise will be determined from vibration measurements. Vibration monitoring equipment would be located outside the room or building in question.

Provisions, Safeguards and Monitoring Contingencies (Ground-borne Noise)

The purpose of this ground-borne noise monitoring contingency is consistent with that of the overall program documented in this NVMoP: it will inform the relevant personnel if the management levels are being approached (or exceeded) so that the work methodology or equipment being used can be altered, and / or additional management measures may be implemented. This will assist to reduce emissions and avoid/minimise impacts so that the surrounding community and broader acoustics environment are safeguarded against further nuisance, or temporary reduction in amenity.

Should circumstances arise during the works where the potential for increased ground-borne noise emissions is identified, or valid complaints are received in this regard; noise monitoring will occur. The processes for measuring and evaluating the measured data presented in this NVMoP will be adhered to. Specific to ground-borne noise, internal noise measurements i.e. inside the affected receivers property will occur, where access is granted.

Ground-borne noise monitoring will enable the site noise level to be established in the absence of any influential source not associated with the WTP Project, and comparison to the predicted values of the relevant DNVIS and management levels presented in the CNVMP.

5.5 Plant and Equipment Noise Levels

All significant noise generating items of plant, that are suspected (by the site staff, ER, AA or Environmental Manager) of having an exceedance of the maximum allowable plant sound power levels listed in the CNVS, would have noise audits conducted in accordance with requirements detailed Section 6.1 of the CNVS.

Noise audits would be conducted upon arrival at a Sydney Metro construction site and at 6-month intervals thereafter. The purpose of these audits is to validate that individual item of plant and equipment fall within the Sound Power Level ranges identified in the CNVS.

Where required, plant and equipment would be measured while operating under typical conditions. If this is not practical, it may be appropriate to conduct a stationary test at high idle. In the case of a sound power level exceeding the values identified in the CNVS the item of plant would either be replaced, or the advice of an acoustic consultant would be sought to provide suitable mitigation measures.

A register of measured sound power levels for each item of plant would be kept for reference where future noise audits are conducted. The register would be reviewed annually.

6 VIBRATION MONITORING

6.1 Attended Vibration Monitoring

Attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels satisfy the criteria for that vibration generating activity. Vibration monitoring will be undertaken at the potentially most affected receivers identified in the DNVIS. Refer Section 8 for target monitoring locations at each construction site.

Where there is potential for exceedances of the criteria further vibration site law investigations would be undertaken to determine the site-specific safe working distances for that vibration generating activity.

Additionally, attended vibration monitoring will be required at any receiver in response to a complaint which may arise at any stage during the construction work.

6.2 Unattended Vibration Monitoring

Unattended continuous vibration monitoring with alarms (i.e. audible/visible, SMS/email) would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the applicable safe-working distances.

In accordance with CoA C16 real-time vibration monitoring will be undertaken throughout the Project at the most affected receiver/structure locations or at representative locations where site vibration level contributions at the nearest sensitive receivers/structures can be monitored.

Where there is potential for levels to exceed criteria, further vibration site law investigations will be undertaken to determine the site-specific safe working distances for that vibration generating activity.

If and when site specific safe working distances are established, continuous unattended vibration monitoring will be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated site specific safe-working distances.

The implementation of all noise and vibration mitigation measures will be monitored regularly throughout the works and audited as per the CEMP audit cycle. Where vibration levels are measured and verified to be compliant, no further vibration monitoring would be undertaken, unless for example complaints for human comfort are received.

6.3 Vibration Monitoring Methodology

Where it is anticipated that an item of plant will exceed the cosmetic damage criteria presented in the CNVMP, vibration monitoring would be required at the nearest affected receiver. Where it is anticipated that an item of plant will exceed the human response / ground borne noise criteria and concerns have been raised regarding vibration, vibration monitoring would also be required at the receiver(s) under question to ensure vibration levels remain below appropriate limits for that structure.

Any vibration monitoring must be undertaken in accordance with the technical guidance provided in the *Environmental Noise Management Assessing Vibration: A Technical Guideline (AVTG)* (DECC, 2006). All vibration monitoring results may be assessed and reported against the acceptable values of human exposure to vibration set out in AVTG, the CNVS and the CNVMP.

All vibration monitoring will be undertaken with due regard to and in accordance with the requirements of the CNVS, AVTG and ICNG using a calibrated vibration logger.

When vibration intensive activities are required e.g. vibratory compaction, sheet piling and demolition, the device will be placed (fixed to the structure or embedded in the ground nearby the structure) at the potentially most affected receiver or structure prior to works commencing.

Where other activities are identified to include risk that levels may exceed structural damage criteria attended vibration monitoring will also be conducted, with measured values to be observed during the first 30 minutes of works (and/or worst-case situation) to ensure structural damage criteria are not exceeded.

Monitoring will be undertaken using tri-axial geophones or accelerometers, which measure vibration as velocity and/or acceleration in three axes.

The device will be set to continuously record vibration levels (PPV data in mm/s) at sample intervals (e.g. 5 second, 15 second or 1 minute) appropriate to the activity. Where possible, the device will also be set to record Vibration Dose Values (VDV, m/s $^{1.75}$).

Vibration Dose Values (VDV, m/s $^{1.75}$) are reliant on:

1. the duration of vibration events and
2. the component frequency (in Hz) associated with the vibration being generated.

Where the monitoring device cannot determine VDV, the VDV will be estimated and evaluated regularly during the early stages of the activity and monitoring period. Based on the estimated VDVs, a PPV trigger level will be established during these early stages to inform the real time management of vibration (e.g. alternate construction methods or respite).

For each monitoring event, the following information will be recorded:

- Date and time of measurements,
- Name of person undertaking the measurements,
- Type and model number of instruments
- Sample times, measurement time intervals and time of day
- Map of area showing measurement location, source location and sensitive receivers
- Measurement location details and number of measurements at each location
- Construction activities and conditions of the equipment under investigation

All vibration monitoring results would be assessed against the nominated vibration goals and compiled into a report to be forwarded to the construction contractor and project manager. Reporting would be submitted to the construction contractor and project manager within one week of being undertaken or at weekly intervals for continuous monitoring. All vibration monitoring reports would also be made available to the public through the publicly accessible website.

6.3.1 Heritage Structures

Where vibration levels are predicted to exceed the screening criteria for a heritage structure, a more detailed assessment of the structure would be undertaken to specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.

Heritage buildings within close proximity to the Project will be assessed by a structural engineer as part of the pre-construction surveys. In the event that a building is deemed structurally unsound during these surveys, the DIN4150 heritage criteria will be applied.

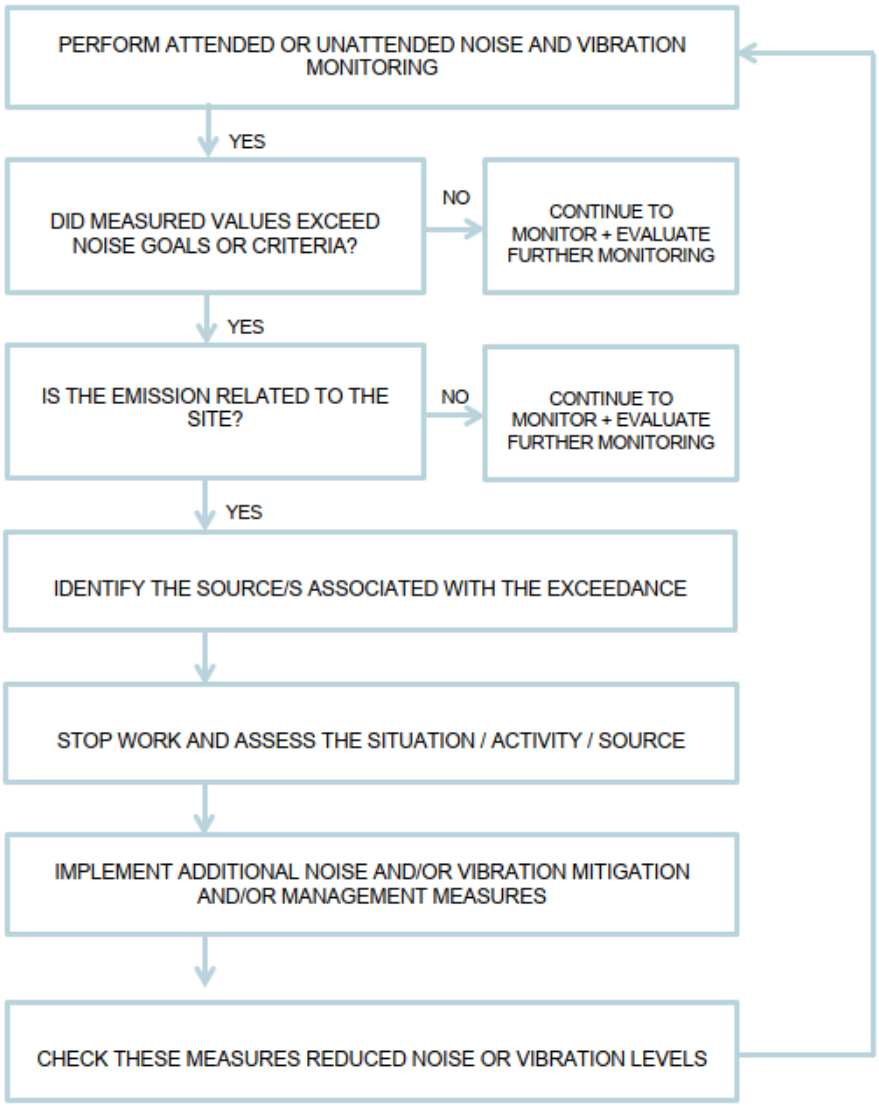
In accordance with CoA D47, GALC will seek the advice of a heritage specialist on methods and locations for installing equipment used for vibration, movement and noise monitoring of heritage-listed structures.

7 MONITORING AND ACTION PROCESS

Actions to mitigate or manage noise or vibration emissions will be considered as per the measures described in the CNVMP and the overall monitoring process identified in Figure 2 below. The Environment Manager / Site Supervisor will be responsible for implementing the Monitoring and Action Protocol outlined below.

This process follows SMART principles in that the actions are specific and measurable, the outcomes are achievable and realistic, and all steps are time-focussed.

Figure 2: Monitoring and Action Protocol



8 TARGET MONITORING LOCATIONS

A summary of the WTP monitoring program is given below in Table 4.

Table 4: WTP monitoring program summary

Construction Site	Target Locations Attended or Unattended	Frequency
Westmead	• 152 Hawkesbury Rd, Westmead • 26-30 Bailey St, Westmead • 2 Hassall St, Westmead	• At the commencement of new construction activities • During OOHW • Where triggered by AMM requirements
Parramatta	• 43 George St, Parramatta • 64 Macquarie St, Parramatta • Roxy Theatre - 69 George St, Parramatta • Kia Ora (heritage property) • Horse Parapet (heritage property)	• At the commencement of new construction activities • Where triggered by AMM requirements
Clyde Dive	• 3 Weston St, Rosehill • 88 James Ruse Dr, Rosehill • Rosehill Gardens Racecourse (Stables) James Ruse Dr, Rosehill • Former RTA Depot (heritage property)	• At the commencement of new construction activities • During OOHW • Where triggered by AMM requirements
Rosehill	• 35-43 Penelope Lucas Ln, Rosehill • Rosehill Gardens Racecourse (Stables) James Ruse Dr, Rosehill	• At the commencement of new construction activities • During OOHW • Where triggered by AMM requirements
Clyde Maintenance and Stabling Facility	• 35-43 Penelope Lucas Ln, Rosehill • Rosehill Gardens Racecourse (Stables) James Ruse Dr, Rosehill	• At the commencement of new construction activities • During OOHW • Where triggered by AMM requirements
Sydney Olympic Park	• 10 Herb Elliott Ave, Sydney Olympic Park	• At the commencement of new construction activities • Where triggered by AMM requirements

Attended vibration measurements will also be required at the commencement of vibration generating activities in close proximity to the following receivers to confirm that vibration levels satisfy the sensitive equipment VC-A criterion:

- SunDoctors Skin Cancer Clinics Parramatta - 239 Church St, Parramatta
- Orthodontics Sydney Wide - 35 Smith St, Parramatta

9 NOISE AND VIBRATION REPORTING

All noise and vibration monitoring results will be assessed against the nominated goals. Noise and vibration monitoring data, and any other relevant information, will be provided to the AA to assist the AA in producing the monthly Noise and Vibration Report as required under CoA A36.

Noise and vibration reports will be produced to demonstrate compliance with noise and vibration project objectives and will be prepared in accordance with the CNVS. The following should be included in as a minimum (where relevant) in noise/vibration monitoring reports for individual monitoring events:

- The type of monitoring conducted (for example, at a particular project stage or following complaints) and a brief statement of the measurement method
- The noise/vibration conditions on the consent / licence, or the relevant noise management objectives
- Descriptions of the nearest affected residences and other sensitive land uses or, in the case of complaints, description of the complainant location and complaint
- Description of the instrumentation used
- The results of monitoring at each monitoring location, including a comparison with the consent conditions or relevant noise management objectives
- Vibration monitoring results summary together with notes describing any vibration intensive activities (if applicable)
- Summary of measurements exceeding the vibration criteria levels and descriptions of the plant or operations causing these exceedances (if available)
- Details of corrective action applicable to vibration criteria exceedances and confirmation of its successful implementation. Where corrective action has not yet been implemented, it may be shown as pending and the status of its implementation will be carried forward to following reports
- The location of the construction works in relation to the monitoring position (e.g. sketches, maps, plans, or photos)
- Details of the various construction equipment in use during the measurement period
- Details as to the likely dominant noise sources
- Meteorological conditions (i.e. temperature, humidity, cloud cover, and wind speed and direction)
- A clear statement outlining the Project's compliance or non-compliance with the noise/vibration management levels
- Strategies for minimising noise/vibration impacts, and the appropriate actions to implement the mitigation and or management strategies.

Data from these individual noise and vibration monitoring reports will be reported in a Construction Monitoring Report in line with CoA C23 (every six months). The Construction Monitoring Report will then be provided to the AA and ER for review and endorsement from the AA prior to submission to the Secretary of the DPIE and relevant regulatory authorities for information.

Reporting requirements associated with the NVMoP for the Project are presented in Table 5.

Table 5: Reporting Requirements and Schedule

Schedule (During Construction)	Requirements	Submission Timeline	Reference
Monitoring reports - Within one week / weekly	Monitoring reports would be submitted to the construction contractor Environment Manager within one week or at weekly intervals for continuous monitoring. Information from external consultants will be used to inform the six monthly monitoring reports mentioned above.	Reports provided one week after the monitoring event. Used to inform the 6 monthly monitoring reports.	CNVS Section 6.3
Noise and Vibration monitoring Reports (every six months)	GALC data summary reports presenting tabulated monitoring data collected during the reporting period and highlighting performance criteria exceedances. Applicable management responses will be documented.	The six-monthly monitoring reports will be provided to the relevant authorities within 40 business days of the monitoring period ending.	CNVS Section 6.2 CoA C23

In line with CoA B11(e), a copy of the Construction Monitoring Report will be published on the project website within a week following submission to DPIE.

Separate from the Construction Monitoring Report, additional records relating to noise and vibration training, toolbox talks, monitoring results and audit results will be prepared, maintained, and stored in line with the CEMP and the CEMF. The complaints management and reporting procedure is described in the CEMP.

Monitoring records separate to the six-monthly Monitoring Report can be requested by the ER and AA throughout the Project for information.

Where the Project EPL has additional requirements for monitoring or reporting results, these will be added to the Monitoring Program once available, in accordance with the process for updating documents as described in the CEMP.

ATTACHMENTS

Attachment 1 – Consultation

Engagement Log

Stakeholder	Date of Engagement/ Attempted Engagement	Date of Any Follow-Up Engagement
EPA	8 April 2022	2 May 2022
SOPA, PCC, CCC	8 April 2022	No Comments

Comments Register

Stakeholder	Comment Raised	GALC Response	Where Addressed
EPA	The EPA generally does not review, approve or endorse monitoring plans, as the role of the EPA is to set objectives for environmental protection and management and not to be directly involved in the development of strategies to comply with such objectives.	Noted.	N/A

Comments Register – Outstanding Issues

Stakeholder	Comment Raised	GALC Response	Proposed Action
N/A	N/A	N/A	N/A