Planning Approval Consistency Assessment Form

SM-17-00000111

Metro Body of Knowledge (MBoK)

Assessment name:	Sydney Metro West – Parramatta – Water Treatment Plant Discharge to Parramatta River
Prepared by:	GLC
Prepared for:	Sydney Metro
Assessment number:	GLC11
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For information – do not alter:

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The Planning Approval Consistency Assessment Form should be completed in accordance with SM-17-00000103 Planning Approval Consistency Assessment Procedure.

1. Existing Approved Project

Planning approval reference details (Application/Document No. (including modifications)):

- SSI-10038 Sydney Metro West – Concept and major civil construction work for Sydney Metro West between Westmead and The Bays (Stage 1 of the planning approval process for Sydney Metro West)
- SSI-10038-Mod-1 The Sydney Metro West Westmead to The Bays and Sydney CBD - Modification 1 (Administrative Modification)
- SSI-10038-Mod-2 The Sydney Metro West Westmead to The Bays and Sydney CBD – Modification 2 (Clyde Stabling and Maintenance Facility)
- SSI-10038-Mod-3 The Sydney Metro West Westmead to The Bays and Sydney CBD - Modification 3 (Administrative Modification)
- SSI-10038-Mod-4 The Sydney Metro West Westmead to The Bays and Sydney CBD – Modification 4 (Administrative Modification)

Date of determination:

- SSI 10038: 11 March 2021
- SSI-10038-Mod-1: 28 July 2021
- SSI-10038-Mod-2: 03 June 2022
- SSI-10038-Mod-3: 04 July 2022
- SSI-10038-Mod-4: 23 December 2022

Type of planning approval: Critical SSI (Division 5.2 “State significant infrastructure”, *Environmental Planning and Assessment Act 1979*)

Approved Project

The approved project includes the Concept and major civil construction works between Westmead and The Bays (Stage 1 of the planning approval process). This Consistency Assessment relates to Stage 1 works, as described below.

Approved Major Civil Construction Work for Sydney Metro West between Westmead and The Bays

Approved major civil construction works for Sydney Metro West between Westmead and The Bays (Stage 1 of the planning approval process) includes the following: (Refer to Section 9 of the Environmental Impact Statement (EIS) for more detail).

- Enabling works, such as demolition, utility supply to construction sites, utility adjustments and modifications to the existing transport network.
- Tunnel excavation including tunnel support activities between Westmead and The Bays.
- Station excavation for new metro stations at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock and The Bays.
- Shaft excavation for services facilities.
- Civil work for the Clyde stabling and maintenance facility.

The location of Stage 1, including the underground tunnel and surface construction sites for the stations and services facilities are shown on Figure 1 below.

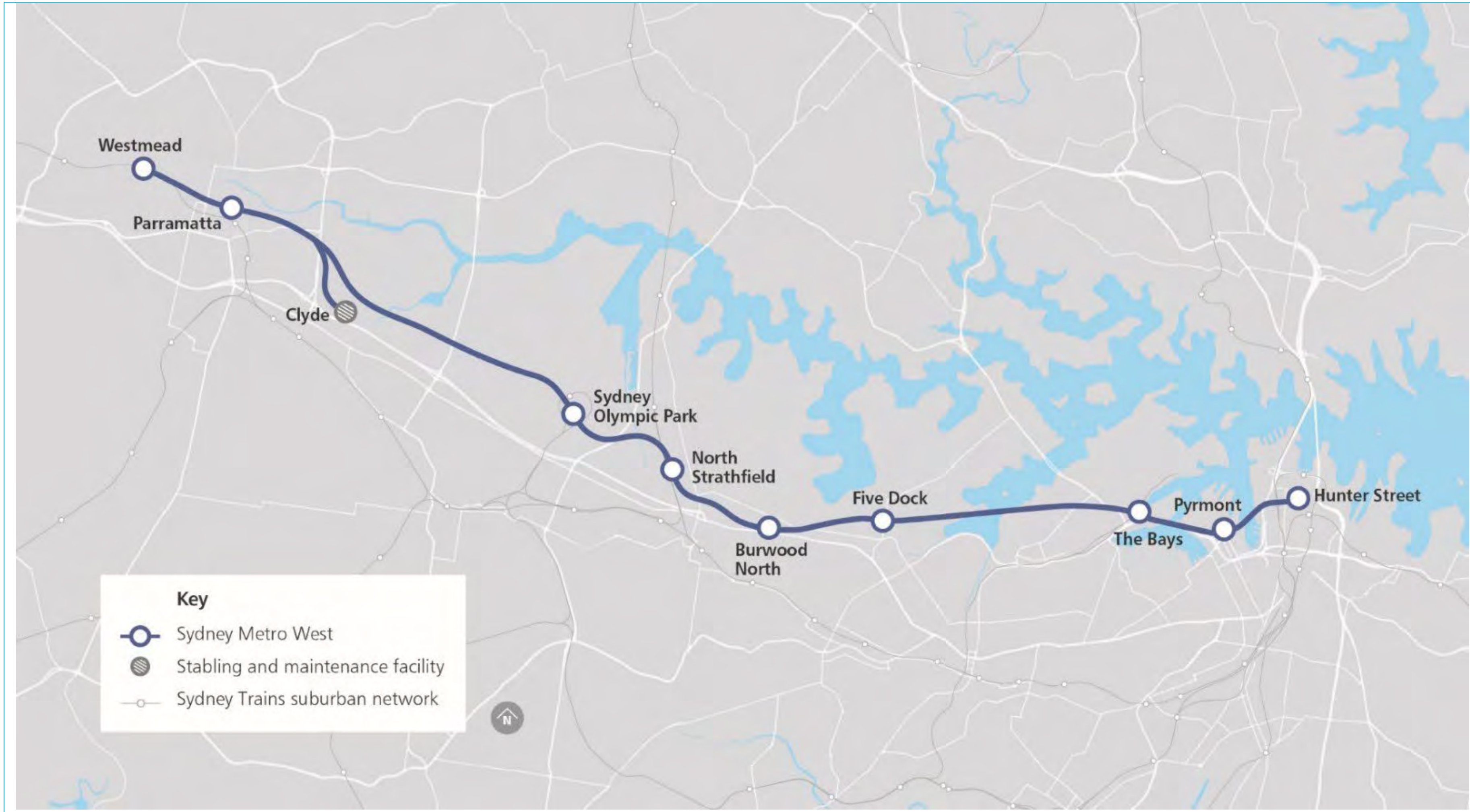

Figure 1: Location of Sydney Metro West - Stage 1

The Project will construct and operate several water treatment plants (WTPs) throughout the duration of tunnel and station excavation works. The WTPs are required to treat:

- groundwater seepage
- Tunnel Boring Machine (TBM) process water
- stormwater runoff, and
- washdown water.

The Parramatta indicative construction site and location of water treatment plant is shown on Figure 2 below:

Figure 2: Parramatta indicative construction site.

Chapter 9 and Chapter 19 of the EIS describes water treatment, with an indicative treatment capacity of 15L/s, to service the Parramatta construction site (EIS section 9.5.3 and 19.6.2). In accordance with Revised Environmental Mitigation Measure (REMM) SSWQ7, the capacity of the WTP is subject to design confirmation. Discharge of the treated water is described in the EIS as being to Parramatta River via existing local stormwater infrastructure (EIS section 19.6.2).

Further design development by GLC has calculated a required treatment capacity of 10L/s for the Parramatta construction site WTP.

This Consistency Assessment has been prepared to support scope of works to carry out the discharge pipeline works along George Street, near the Parramatta construction site to install the required WTP discharge pipeline that will carry the treated water to an existing stormwater pit ultimately discharging to Parramatta River. The discharge pipeline works primarily involve the excavation of trenches to lay the new discharge pipeline from the Parramatta WTP to the corner of George Street and Charles Street, where a suitable stormwater drainage outlet to the Parramatta River is located. A large portion of the discharge line (refer to Figure 3 below) is located outside the project boundaries (but in the vicinity of the tunnelling alignment) as identified for the approved project. A targeted assessment of the Parramatta WTP discharge route scope of works was not conducted for the approved project, and as such, the existing environment, potential impacts, and additional mitigation measures (if any) for the discharge pipeline works are subject to the assessment undertaken in this Consistency Assessment.

This Consistency Assessment has been prepared using the approved project information and site descriptions for construction activities between Sydney Olympic Park and Parramatta, as documented in the 'Relevant background information' section below.

Relevant background information (including EA, REF, Submissions Report, Director General's Report, MCoA):

This Consistency Assessment has been undertaken for the Sydney Metro West Concept and major civil construction work for Sydney Metro West between Westmead and The Bays (Stage 1 of the planning approval process). This includes the following planning approval documentation:

- Sydney Metro West - Westmead to The Bays and Sydney CBD (Concept and Stage 1) Environmental Impact Statement (15 April 2020)
- Sydney Metro West - Westmead to The Bays and Sydney CBD (Concept and Stage 1) Submissions Report (20 November 2020)
- Sydney Metro West - Westmead to The Bays and Sydney CBD (Concept and Stage 1) Amendment Report (20 November 2020)
- Sydney Metro West - Westmead to The Bays and Sydney CBD (Concept and Stage 1) Modification 1 - Administrative Modification (28 July 2021)
- Sydney Metro West - Westmead to The Bays and Sydney CBD (Concept and Stage 1) Modification 2 - Clyde Stabling and Maintenance Facility Modification Report (03 June 2022)
- Sydney Metro West - Westmead to The Bays and Sydney CBD (Concept and Stage 1) Modification 2 - Clyde Stabling and Maintenance Facility Submissions Report (March 2022)
- Sydney Metro West - Westmead to The Bays and Sydney CBD (Concept and Stage 1) Modification 3 - Administrative Modification (04 July 2022)
- Sydney Metro West – Westmead to The Bays and Sydney CBD (Concept and Stage 1) Modification 4 – Administrative Modification (23 December 2022)
- Consolidated Instrument of Approval – Sydney Metro West – Concept and Stage 1 – Conditions of Approval (23 December 2022)

All documentation has been published on the Department of Planning and Environment Major Projects website located here (Major Project Number: SSI-10038): https://www.planningportal.nsw.gov.au/major-projects/project/25631

Other relevant documentation prepared as part of design development and construction planning include:

- GLC12 Environmental Review – Non-Destructive Digging (NDD) for confirmation of the Parramatta Water Treatment Plant Discharge Route.

All proposed works identified in this assessment would be undertaken in accordance with the mitigation measures identified in the Environmental Impact Statement, Submissions Report and Amendment Report and the Minister's Conditions of Approval (MCoA).

2. Description of Proposed Development/Activity/Works

The purpose of this Consistency Assessment (CA) is to assess potential impacts of the location and methodology for installing the WTP discharge pipeline for the Parramatta metro station construction site. Treated water will be discharged to the estuarine reaches of the Parramatta River, downstream of Charles Street Weir via existing stormwater infrastructure. The existing stormwater infrastructure (stormwater pit) is located outside project boundary on the corner of George and Charles Street and therefore a large portion of the discharge pipeline (the portion which is the subject of this CA) will also be located outside the project boundary of the Parramatta construction site.

An alternative route was initially proposed (indicated in Figure 3) however following a heritage assessment it was found that the route was crossing the heritage Parramatta Convict Drain at three separate locations and the route had to be redesigned. The new discharge pipeline, which is the subject of this Consistency Assessment, will run from the northern side of the Parramatta construction site along George Street, to where the existing stormwater pit is located (indicated in Figure 3). This route only crosses the Parramatta Convict Drain at one location therefore minimising interface with and the risk of impacting the heritage listed drain. The pipework outside project boundary will completely be installed underground.

Heritage Non-Destructive Digging (NDD) works (GLC12 Environmental Review) have been conducted to confirm the location and depth of the Parramatta Convict Drain where the proposed WTP discharge pipeline crosses it. The Convict Drain was located under the 85 George Street driveway concrete slab at a depth of approximately 500mm. The proposed route, crossing the Convict Drain at this location was confirmed to be viable with no impacts to the Convict Drain anticipated. As per the methodology described for the NDD investigation works, a conduit was laid over the Convict Drain to remove the need of further exposure of the Convict Drain when the proposed discharge pipeline is eventually installed. Due to low cover for a trafficable area over the Convict Drain, and to prevent any impact to the discharge pipeline at that location, the installation of a mechanical blocker, either a cover slab or steel plate, has been suggested. The Archaeological Assessment can be found in Appendix A.

Works will include:

- Installation of 1 x 150mm diameter high density polyethylene (HDPE) pipe from the Parramatta WTP to connect to existing stormwater infrastructure, approximately 350m in length. This pipework will be installed outside the construction site from the north of the site, along George Street, to the stormwater pit located on the corner of George Street and Charles Street. A 150mm diameter pipe will furthermore be laid within the construction site to connect the water treatment plant to the high-density polyethylene (HDPE) discharge pipeline. This pipe will be installed above-ground using hand tools.

- Trenching through existing footpaths and roadways to a proposed maximum depth of 1.0m.
- Trenching will generally be through the roadways along George Street. A small portion of the trenching will be through the footpath along George Street, to connect to the conduit that was installed previously as part of the NDD investigation works described in *GLC12 Environmental Review*.
- Installation of a mechanical blocker, either a cover slab or steel plate over the previously installed conduit over the Parramatta Convict Drain.
- Removal of spoil and stockpiling at designated area on Project site for testing.
- Backfilling of the trenches using stabilised sand.
- Reinstatement of the road.
- Connection of the HDPE pipe (discharge pipeline) to the existing stormwater drainage pit on the corner of George Street and Charles Street.

Proposed Methodology

As shown in Figure 3, the section of the 150mm diameter HDPE discharge pipeline to carry the treated water from the Parramatta WTP that will be installed outside of project will commence from the northern side of the Parramatta site on George Street.

The discharge pipeline will then run south-eastwards within the George Street roadways to the corner of George Street and Charles Street. The discharge pipeline route will be constructed below ground, via trenches of approximately 0.6m wide x 0.8m deep (maximum of 1.0m). The discharge line will be installed in a number of smaller sections to ensure works can be reinstated or covered with steel plates at the end of each night to allow for normal traffic during the day. Equipment may include saw cutters, excavator, tipper truck, vac truck, bogie, lighting plant, plate compacter, light vehicle(s), and hand tools. The discharge pipeline will be connected to the top of the stormwater pit wall at a 90º bend by excavating to approximately 1.0m deep, using a core drill to create an opening for the discharge pipeline and using cement mortar, or similar, to seal. Between the Parramatta water treatment plant (WTP) outlet, located on the north-western corner of the WTP, and the HDPE discharge pipeline (inside the existing construction site boundaries) a connection pipe will additionally be installed above ground. The discharge pipeline will be installed to minimise clearance of mature trees and other vegetation. The trenches will be reinstated using stabilised sand (for backfilling) and hot mix asphalt.

Considering the works are primarily conducted in the road along George Street, temporary traffic arrangements will need to be made. Only one road closure will be required for the duration of the works, Barrack Lane will need to be closed for a maximum of 3 nights. Furthermore, Smith Street is a 4-lane road (2 in each direction) that will need to be crossed one lane per night to allow for minimal impact to the usual traffic (including 24-hour bus route) along Smith Street.

The pipes will be joined via Butt Welding. Once sections of the discharge pipeline have been installed, they will be pressure tested to ensure they have been correctly installed and no risk of leaks are present. A final full system test will be undertaken once the complete discharge route has been installed. Discharge to Parramatta River will be in accordance with conditions applied in the Gamuda Berhad EPL 21676 for Sydney Metro West – Western Tunnelling and Eastern Creek. Landowners consent will be sought prior to the works commencing and the use of their asset. Landowners include the City of Parramatta Council, TfNSW and utility providers, as required. At the completion of the Tunnelling Contractor scope of works, the pipework will remain in place and handed over to the follow-on contractor (scheduled for Quarter 3 in 2025).

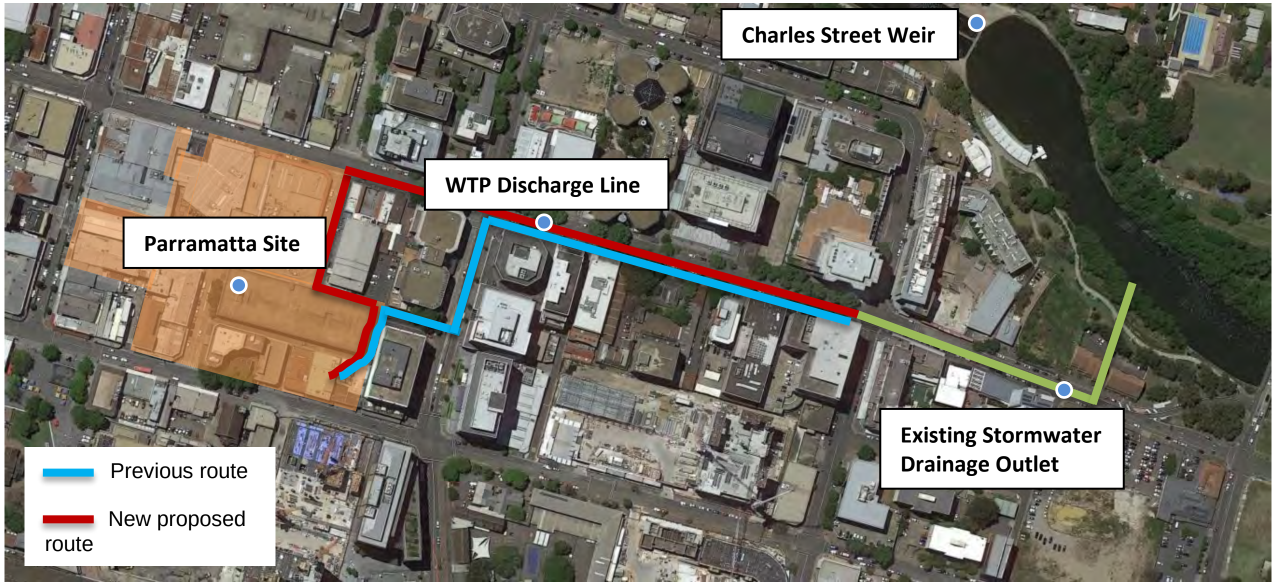

Figure 3: Location of WTP Discharge Pipeline Route

3. Timeframe

Discharge pipeline installation works will take approximately 5 weeks to complete. It is expected that these works will be undertaken in May/June 2023, dependent on the approval timeline for this Consistency Assessment. The proposed works will occur out-of-hours (OOH) as the works are located on, across or adjacent to active roads and will require disruption to traffic and community via road / lane closures as well as restricted pedestrian access. All OOHW would be managed in accordance with the Project Noise and Vibration Management Plan and the Project EPL 21676.

4. Site Description

Parramatta metro station construction site

As described in Chapter 9 of the EIS, the Parramatta metro station construction site covers about 24,150 square meters within the block bunded by George, Church, Macquarie, and Smith streets. The site previously contained commercial buildings and a multi-storey car park. The discharge pipeline is located outside the construction boundary of the Parramatta metro station construction site and runs from the northern side of the Parramatta metro station construction site along George Street, to the corner of George and Charles Street.

5. Site Environmental Characteristics

The proposed discharge pipeline works are located in proximity to the Parramatta metro station construction site. As these sites are located outside the surface construction site boundaries, environmental characteristics for each site have not been previously described as part of the approved project. A desktop assessment, review of the EIS and supporting assessments, as well as a site inspection in February 2023 was undertaken to understand the existing environment and potential impacts associated with the proposed works. A summary of the site environmental characteristics for the Parramatta construction site includes:

Land Use

- A review of the NSW Spatial Services Historical Imagery Viewer was undertaken in August 2022 to understand the historic and current land use for each project site. The land surrounding the Parramatta construction site was typically used for agricultural purposes and residential areas prior to the 1950s. Parramatta CBD gradually developed into commercial precincts leading up to the early 2000s. Currently, the location of the proposed discharge pipeline sits within industrial, commercial, and residential land use areas.
- Parramatta construction site is located to the north of the existing Parramatta Train Station, within the commercial core of the Parramatta CBD. The Parramatta CBD commercial core comprises a wide mix of commercial, retail, health, government administration and community use.

- Land uses surrounding the Parramatta metro station construction site include the following:
    - North of the construction site are retail and commercial properties, as well as the riverside cultural and entertainment precinct, which is between the construction site and Parramatta River.
    - East of the construction site along George Street is the Roxy Theatre and various retail and commercial properties of medium density. The Arthur Phillip High School and Parramatta Public School (both currently being redeveloped as multi-storey vertical schools) are located south-east of the site.
    - South of the site is Parramatta Square, which is being redeveloped around the Parramatta Town Hall and will include a new civic square, public open space, regional community facilities, retail, and entertainment facilities, and seven new commercial office towers. Beyond Parramatta Square is the Parramatta transport interchange, which provides access to the existing Parramatta Station and bus services. Beyond the existing rail corridor is the major retail quarter around the Parramatta Westfield.
    - West of the site is a combination of retail, educational and commercial uses. To the immediate west of the site is the Church Street restaurant destination (known as Eat Street). Beyond Church Street is the Parramatta justice precinct, which includes a police station and several courthouse buildings. Parramatta Park is about 300 metres to the west of the site, with BankWest Stadium about 500 metres to the north-west, across the Parramatta River.

Soils and Contamination

- In addition to reviewing the EIS and supporting documents, a search of the NSW Environmental Protection Authority (EPA) public registers and the NSW DPE eSPADE portal was undertaken in August 2022. The proposed WTP discharge line is located on the Cumberland Plain, an extensive low-lying plain within the Cumberland Basin, within four soil landscapes: Birrong, Blacktown, Disturbed Terrain, and Glenorie. Areas around the Parramatta River are identified as “disturbed terrain”. These areas are often located on reclaimed land, within dredged/mined areas, or on fill and/or alluvium and are often associated with the potential presence of acid sulfate soils. The detailed site investigation conducted for Parramatta is mapped as having a low probability of Acid Sulfate Soils (ASS) occurrence. The site is classified as Class 4 ASS risk in the southern portion. For Class 4 ASS risk, development consent is required for carrying out works at 2 meters below the natural ground surface or works by which the water table is likely to be lowered more than 2 meters below the natural ground surface.
- Overall, the soils, groundwater, and vapour in the vicinity of the Parramatta construction site have a moderate potential contamination risk due to current and historical activities.
- The discharge pipeline will most likely be installed above existing sewer lines and no contaminated soils are expected at the proposed locations. Nevertheless, GLC’s Unexpected Finds Protocol will be followed in the event of a find.

Aboriginal and Non-Aboriginal Heritage

- The Parramatta CBD has grown from an early convict settlement based around the presence of arable land for farming.
- In the original assessment of the project, only the Parramatta Convict Drain was identified as a heritage item along the proposed trenching route.
- A Heritage Due Diligence Assessment was also undertaken to understand the potential impacts of the proposed discharge route on the listed heritage items and Aboriginal sites within the vicinity of the proposed works, which are identified in Appendix B of this Consistency Assessment. The main characteristics obtained from the Assessment includes:
  - The study area overlies the Parramatta Sand Body, on which Aboriginal people started living around 40 000 years ago.
  - The areas occupied by Aboriginal people contain evidence for stone artefacts, hearts, cooking pits and flat sandstone plates they transported into their living areas.
  - No registered Aboriginal Heritage Information Management System (AHIMS) sites are within the study area (proposed discharge route).
  - It is common for Aboriginal sites to be in close proximity to a water course, such as the Parramatta River
  - There is potential for localised areas in the study area to contain remnant Parramatta Sand Body (PSB) deposits, and there is a low potential for the presence of Aboriginal objects in these deposits.
  - Before You Dig service searches identified a number of services in the vicinity of the discharge route which suggests that the area is likely to have been heavily impacted by excavation for existing service trenches.
- During the NDD investigation works, the Convict Drain was located, and a conduit was installed above the Convict Drain to facilitate the installation of the discharge line without impacting the Convict Drain.

Hydrology and Water Quality

The proposed discharge pipeline is located within 250m of the Parramatta River (which is north-east of the proposed line).

- The construction site is located on a largely flat area with a slight northerly slope towards Parramatta River. Stormwater drainage flows to the north of the site, discharging to the Parramatta River.

Noise and Vibration

- Qualitative Construction Noise and Vibration Impact Statements (CNVIS) were prepared to assess the potential noise and vibration impacts associated with the discharge pipeline works.
- Existing noise levels around the Parramatta construction site are dominated by road traffic noise and the general urban noise associated with the Parramatta CBD.

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- The area surrounding the construction site is mainly commercial, typically general office or retail use and includes one noise catchment area: NCA03. NCA03 covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many ‘other sensitive’ receivers in this catchment, including Western Sydney University – Parramatta, Arthur Phillip High School, Parramatta Public School, and several nearby hotels and places of worship.

Biodiversity

- The habitat within the construction footprint has a low degree of connectivity to other areas of habitat due to impacts of urbanisation.
- The Parramatta construction site consists of commercial development with no existing natural vegetation. Street trees and plantings along Horwood Place include the native species *Eucalyptus botryoides* and *Acacia binervia*. The remainder of the vegetation consists of exotic trees and opportunistic weeds occurring in garden beds and alongside buildings and the roadside.
- A large Moreton Bay heritage fig tree is located at 89 George Street, Parramatta.

Traffic, Transport and Access

- There will be temporary traffic impacts from the proposed works due to the interface with George Street and a portion of the pedestrian walkway. All works will take place out of hours due to the temporary traffic impacts and relevant out of hours work (OOHW) permits will be obtained.
- The commercial and residential properties that have driveways exiting onto George Street in the vicinity of the proposed discharge route would be consulted with in accordance with the Sydney Metro Overarching Community Communications Strategy, to further understand the impacts of the proposed work and any cumulative impact from the approved project. Furthermore, Barrack Lane will temporarily need to be closed for a maximum of 3 nights, and necessary arrangements will be made with the relevant commercial/residential properties in accordance with Condition of Approval D80.
- George Street is a key road near the construction site, with high volumes of traffic occurring during peak morning and peak evening period as well as high levels of pedestrian activity. The Parramatta Free Shuttle route (Route 900) and Route 545 (Parramatta to Macquarie Park) run through George Street where the proposed works will be taking place; no impact to the bus routes are however expected considering the former operates from 7:00am to 7:00pm and the latter runs east on George Street. On-street paid parking is also provided on several sections of George Street, particularly east of Smith Street.

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6. Justification for the Proposed Works

The works proposed under this Consistency Assessment would be consistent with the objectives and functions of the approved project. GLC are proposing to install a water discharge pipeline for the WTP that runs from the Parramatta construction site, along George Street and into an existing stormwater system that drains into Parramatta River. The EIS states in:

- Section 9.5.2 that the Parramatta metro station construction site will include water treatment and disposal.
- Section 19.6.2 that any surplus wastewater would be treated before discharge to the local stormwater system or directly to a local surface watercourse.
- Section 24.5.3 that the surplus of treated water (after the potential onsite water uses are exhausted) would be discharged to the local stormwater system or directly to a local surface watercourse.

Detailed design has now been undertaken for the water discharge pipeline from the Parramatta metro station construction site. This Consistency Assessment assesses the specific discharge route of the treated water and exact location of disposal now that detailed design has been undertaken.

7. Environmental Benefit

The installation of a mechanical blocker, either a cover slab or steel plate, over the already installed conduit (NDD works - GLC12 Environmental Review) where the discharge line crosses the Parramatta Convict Drain in the footpath along George Street protects the Convict Drain by preventing future direct impact and by strengthening the footpath above the drain which is also used as a driveway.

8. Control Measures

The proposed works would be undertaken in accordance with the mitigation measures and the conditions of approval for the approved Sydney Metro West – Stage 1 project. Any additional mitigation measures identified in this assessment will be implemented as required. The proposal would be managed in accordance with the approved Construction Environment Management Plan (CEMP) and CEMP Sub-plans.

9. Climate Change Impacts

No change in climate change risk (as identified in the EIS) will occur as a result of the proposed discharge pipeline works.

10. Impact Assessment – Construction

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed/activity, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
Flora and fauna	Trenching will mostly take place on the roadways of George Street, only a small portion of the discharge line will be installed on the footpath (85 George Street driveway), so as to cross the Parramatta Convict Drain using the previously installed conduit. No clearing of vegetation is expected during the works. Tree roots may be encountered on the route. In compliance with the Fauna and Flora Management Plan (FFMP), an arborist will be present for the cutting of roots, if required	No additional measures required.	Y	Y	
Water and soils	The proposed works would have negligible impact on groundwater, as there will be no interaction with groundwater considering the trenches are shallow excavations. There is potential for impact on surface water, especially during heavy rainfall, due to the excavation works being undertaken on the road near stormwater drains and close to the Parramatta River. However, the work will be managed in accordance with the Soil and Water Management Plan and the detailed Environmental Control	No additional measures required	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed/activity, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	Maps (ECM) and Erosion and Sediment Control Plan (ESCP). Soils and surface water quality are anticipated to be consistent to the assessed Project. As such, no additional impacts to the approved project are anticipated as a result of the proposed works.				
Air quality	No additional impacts to the approved project, as the proposed works will only generate minor, localised air quality emissions from the operation of plant and machinery. No additional impacts to the approved project as a result of the works.	No additional measures required.	Y	Y	
Noise and vibration	Construction Noise and Vibration Impact Statements (CNVISs) were prepared by GLC to assess potential noise and vibration impacts of the associated discharge pipeline installation works during out-of-hours (OOH). The assessment has been conducted in four (4) sections along the route. This was done to assess the noise and vibration impacts on receivers as they will progress along the route instead of as a cumulative impact on all the receivers every night. For each of the four (4) sections the various works that need to take place were	No additional measures required. The mitigation measures identified within the Sydney Metro Construction Noise and Vibration Strategy and the project specific CNVMP and DNVIS would be implemented where feasible and reasonable, and considering the out of hours works required. This would include:	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed/activity, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	furthermore divided into three stages as they will be taking place consecutively. The three stages of work are: (1) saw cutting (only during evening hours), (2) non-destructive digging (NDD) and pavement removal, and (3) installation of the pipeline and reinstatement of the surface. A CNVIS was prepared for each stage of work, at each individual section along the route. The twelve (12) various CNVISs can be found in Appendix B. For each of the sections, the stage with the most significant impact (worst case scenario) is Stage B: *NDD and Pavement removal.* The remainder of the stages (Stage A and Stage C) has lower impacts due to the works requiring equipment with lower sound power levels. The impacts during the worst case scenario (Stage B) for each of the individual sections are: Section 1:	• The minimum sized equipment necessary to complete the work would be used are used • Portable noise barriers around noise intensive activities would be installed where possible. • Respite periods for noise intensive activities would be provided • Shut down plant and machinery, including vehicles when not in operation • Notification to potentially affected receivers prior to OOHW • Noise and vibration monitoring during works to confirm predictions. Monitoring locations should be targeted to most affected receivers or representative locations nearby.			

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed/activity, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	• Would impact up to 84 residential receivers at NML exceedances of 0-10dB. • Sleep disturbance criteria is triggered at 48 residential receivers. Section 2: • Would impact up to 62 residential receivers at NML exceedances of 0-10dB. • Sleep disturbance criteria is triggered at 44 residential receivers. Section 3: • Would impact up to 45 residential receivers at NML exceedances of 0-10dB and up to 19 residential receivers at NML exceedances of 11-20dB. • Sleep disturbance criteria is triggered at 56 residential receivers. Section 4: • Would impact up to 61 residential receivers at NML exceedances of 0-10dB, up to 37 residential receivers at NML exceedances of 11-20dB, up to 21 residential receivers at NML exceedances of 21-30dB and up to 3 residential				

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed/activity, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	receivers at NML exceedances of >30dB. • Sleep disturbance criteria is triggered at 86 residential receivers. It is important to consider that the works will progress along George Street, with only one section being worked on at a time and therefore any one receiver will only be impacted for a maximum duration of approximately one to two weeks. Other sensitive receivers (non-residential) along the discharge route include the Western Sydney University International College and the Reggio Emilia Early Learning Centre. However, considering the works will only be taking place outside of standard hours (and therefore outside of the University and Learning Centre operating hours) no impacts to these receivers are predicted.				
Aboriginal heritage	The Archaeological Assessment in Appendix A confirms that the excavation for the discharge line would have the potential for localised impact on Aboriginal heritage where archaeological finds are present within the trench footprint. However, the study area has a low to moderate potential to contain Aboriginal	No additional measures required. The relevant control measures identified in the Sydney Metro West – Western Tunnelling Package – Heritage Management Plan will be implemented where	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed/activity, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	objects, and therefore the overall impact of the work is concluded as low to moderate. The approved project was assessed as having direct impact on Aboriginal archaeology, due to an AHIMS site being present with the Parramatta metro station construction site boundary. However, considering the construction site and the discharge line are both located on the Parramatta Sand Body (PSB), the risk of finding Aboriginal objects and the associated impacts of the work proposed in this Consistency Assessment is consistent with the approved project.	applicable. The Sydney Metro Unexpected finds protocol will furthermore be implemented if any heritage objects are identified during the works.			
Non-Aboriginal heritage	Excavation for the discharge line would have the potential for localised impact on non-Aboriginal heritage if archaeological finds are present within the trench footprint. Considering the study area (discharge route) has a low potential to contain non-Aboriginal objects - due to the likelihood of being heavily impacted by excavations for existing service trenches – little to no impact of the proposed works to non-aboriginal heritage is anticipated. The only heritage item that was initially identified in the EIS that would be along	No additional measures required. The relevant control measures identified in the Sydney Metro West – Western Tunnelling Package – Heritage Management Plan will be implemented where applicable. The Sydney Metro Unexpected heritage finds procedure will furthermore be implemented	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed/activity, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	the discharge route is the Parramatta Convict Drain. The Archaeological Assessment in Appendix A confirms that no impact to the Convict Drain is expected as the discharge line will be installed through the conduit that has been laid above the Convict Drain. This is consistent with the original approved project, as no to little impact to the Parramatta Convict Drain was predicted.	if any heritage objects are identified during the works.			
Community and stakeholder	It is anticipated some receivers in NCA03 would experience additional noise impacts. The majority of receivers are commercial receivers along the proposed trenching route; however, a small portion of residential receivers are expected to be impacted at the very eastern section of the works. These receivers will be managed using the relevant measures specified for the approved project. Some paid parking spaces will be temporarily removed along George Street to enable the works. Parking spots will only be closed at night at the section that works will occur for that specific night. Considering works will progress at approximately 10-15m sections per night a	No additional measures required. In accordance with Condition of Approval D80, access across pedestrian or shared user paths would be maintained at all times unless alternative access is agreed with the relevant utility owner, landowner or occupier. Land access approvals will be sought prior to commencement of works. Consultation by GLC is occurring with relevant councils and stakeholders for works outside project	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed/activity, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	maximum of 5 parking spaces would need to be removed per night. The pipeline route crosses a maximum of 5 driveways which will temporarily need to be partially closed during the proposed works, however timing of this will be based on the progression of works. Each driveway will need to be partially closed at night for a maximum of one (1) week. Most driveways being from commercial properties, the impact on stakeholders will be limited as only night closure is required. While the driveway will be partially closed, access to vehicles and pedestrian will be maintained. Consultation would continue with stakeholders, and updates would be provided through communication streams already established through the approved project in accordance with the Sydney Metro Overarching Community Communications Strategy. As such, no additional impacts to the approved project are anticipated as a result of the works.	boundary proposed in this Consistency Assessment. Updates will be regularly provided as per the Sydney Metro Overarching Community Communications Strategy.			
Traffic	Temporary traffic-related impacts are anticipated during the proposed discharge pipeline works. The discharge pipeline is on a roadway as well as a footpath. It	No additional measures required. Construction Traffic Management Plans (CTMPs)	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed/activity, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	crosses roads and driveways, and temporary uses paid parking spots along George Street. Smith Street consists of 4 lanes with regular traffic and multiple bus routes that operate during the night. To minimize the traffic related impacts on Smith Street, works will require only one lane to be closed per night. Furthermore, Barrack Lane will temporarily need to be closed for a maximum duration of 3 nights. The Parramatta Free Shuttle route (Route 900) and Route 545 (Parramatta to Macquarie Park) run through George Street where the proposed works will be taking place; no impact to the bus routes are however expected considering the former operates from 7:00am to 7:00pm and the latter runs east on George Street. A Traffic Control Plan (TCP) will be developed and implemented for the duration of the works. All works will be taking place out of hours, to reduce the traffic related impacts. Consultation with the potentially impacted commercial properties would be undertaken in accordance with the Sydney Metro Overarching Community Communications Strategy. .	as required by CoA D85 will be prepared in accordance with the Construction Traffic Management Framework. All work on or adjacent to roads would be carried out in accordance with a relevant TCP and/or ROL to facilitate safe work near live traffic. A road dilapidation report would be prepared prior to the works commencing in accordance with the conditions of approval.			

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed/activity, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
Waste	There may be minor volumes of spoil generated as a result of the discharge pipeline installation. The works will be taking place simultaneously to the detailed site investigation to reduce the potential impact to the local community through reduced risk to utilities, reduced impacts as a result of traffic disruptions and the need for work out of hours and a more consolidated works program. An A9 request was made and approved on 4 April 2023. The installation of the pressure pipeline will result in approximately 100m^3 of spoil. Stockpiling and classification prior to reuse or disposal is considered the most suitable method for managing the minor volume of spoil generated by these works.	No additional measures required. Spoil will be stockpiled within the appropriate Project site and tested and classified prior to reuse or disposal in accordance with Waste Classification Guidelines (NSW EPA, 2014) in accordance with CoA D114. The Unexpected Contaminated Land and Asbestos Finds Procedure as required by the Sydney Metro West – Western Tunnelling Package – Waste Management Plan will be implemented where applicable.	Y	Y	
Social	Some of the proposed works will have temporary impacts with the local community including businesses due to their locations (e.g., footpaths, near sensitive receivers) as a result of potential noise, amenity and access impacts. Consultation would continue with stakeholders in line with the approved project, and updates would be provided	No additional measures required. The Sydney Metro West – Western Tunnelling Package – Noise and Vibration Management Plan and the Overarching Community Communication Strategy will be implemented where applicable	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed/activity, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	through the existing communication streams. As stipulated in GLC's Noise and Vibration Management Plan, the relevant additional mitigation measures will be applied to all sensitive receivers. The level of noise impact would define the appropriate notification processes (e.g., door knock, respite offers) in accordance with the Sydney Metro Construction Noise and Vibration Standard.				
Economic	The proposed discharge pipeline works will have a temporary impact on local businesses (e.g., restaurants, bars) due to the location. The impacts (e.g., parking spaces availability, noise, footpath access) will be of short duration and will be managed via consultation processes outlined in the Sydney Metro Overarching Community Communications Strategy.	No additional measures required. Where businesses adjacent to the discharge pipeline works are operating, GLC will take all reasonably practicable measures to maintain access to affected properties in accordance with CoA D80. In the event that we cannot avoid this disruption, alternative access and parking arrangements in consultation with those businesses affected would be provided. The provision of appropriate wayfinding will be provided prior to any disruption. Consultation is occurring with relevant	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed/activity, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
		businesses and stakeholders for the works and updates will be regularly provided through communication streams for the approved project.			
Visual	There will be minor changes to the George Street roadway and footpaths when works are being undertaken, due to a lighting plant required during night-time works as well as acoustic mitigation measures such as noise mats. However, these will have minimal impacts due to the temporary nature of the works. The discharge pipeline will be installed underground, and the trenches will be backfilled and reinstated following the works. As such no permanent visual impacts to the approved project are anticipated considering the works will not permanently alter the visual landscape of the impacts will however these will be temporary in nature and the sites will be reinstated to their previous condition once works are completed. As such, no additional impacts to the approved project are anticipated as the proposed discharge pipeline works will not permanently alter the visual landscape of each site.	No additional measures required.	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed/activity, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
Urban design	No additional impacts to the approved project.	No additional measures required.	Y	Y	
Hydrology and flooding	The proposed works would have negligible impact on surface water, as there will be minimal ground disturbance near watercourses. There is potential for erosion and sediment impacts, however these will be minimised with the implementation of appropriate control measures.	No additional measures required. Erosion and sediment impacts would be managed in accordance with the Sydney Metro West – Western Tunnelling Package – Soil and Water Management Plan. In addition, appropriate erosion and sediment controls will be implemented in accordance with the Blue Book and Attachment 3 (Erosion and Sediment Control Plan) of the Soil and Water Management Plan.	Y	Y	
Land use	No additional impacts to the approved project, as the proposed works will only temporarily change the existing land use during pipe installation.	No additional measures required.	Y	Y	
Contamination	Minor volumes of spoil material would be managed in accordance with the waste procedure outlined above.	No additional measures required.	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed/activity, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	Excavation may also pose a risk to receiving environments, primarily Parramatta River, from potentially contaminated material. Erosion and sediment risks would be managed in accordance with the Soil and Water Management Plan and the detailed Erosion and Sediment Control Plan (ESCP).				
Climate change	The use of minor plant/equipment and light vehicles required to undertake the discharge pipeline installations works are the only anticipated source of any greenhouse gas emissions proposed under this Consistency Assessment. As such, no additional impacts to the approved project are anticipated.	No additional measures required.	Y	Y	
Risk	No additional impacts to the approved project.	No additional measures required.	Y	Y	
Other	No additional impacts to the approved project.	No additional measures required.	Y	Y	
Management and mitigation measures	No additional impacts to the approved project.	No additional measures required.	Y	Y	

11. Impact Assessment – Operation

The proposed discharge pipeline works will not impact any aspects of operations and is entirely limited to the construction phase.

Furthermore, Stage 1 of the planning application for Sydney Metro West (subject of this Consistency Assessment) is for major civil construction work for Sydney Metro West between Westmead and The Bays. As discussed below, operational impacts of the proposal are negligible, and therefore there are no changes from the approved project are anticipated.

Aspect	Nature and extent of impacts (negative and positive) during operation (if control measures implemented) of the proposed activity/works, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
Flora and fauna	No change from the approved project.	No additional measures required.	Y	Y	
Water	No change from the approved project.	No additional measures required.	Y	Y	
Air quality	No change from the approved project.	No additional measures required.	Y	Y	
Noise vibration	No change from the approved project.	No additional measures required.	Y	Y	
Aboriginal heritage	No change from the approved project.	No additional measures required.	Y	Y	
Non-Aboriginal heritage	No change from the approved project.	No additional measures required.	Y	Y	
Community and stakeholder	No change from the approved project.	No additional measures required.	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during operation (if control measures implemented) of the proposed activity/works, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
Traffic	No change from the approved project.	No additional measures required.	Y	Y	
Waste	No change from the approved project.	No additional measures required.	Y	Y	
Social	No change from the approved project.	No additional measures required.	Y	Y	
Economic	No change from the approved project.	No additional measures required.	Y	Y	
Visual	No change from the approved project.	No additional measures required.	Y	Y	
Urban design	No change from the approved project.	No additional measures required.	Y	Y	
Geotechnical	No change from the approved project.	No additional measures required.	Y	Y	
Land use	No change from the approved project.	No additional measures required.	Y	Y	
Climate Change	No change from the approved project.	No additional measures required.	Y	Y	
Risk	No change from the approved project.	No additional measures required.	Y	Y	
Other	No change from the approved project.	No additional measures required.	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during operation (if control measures implemented) of the proposed activity/works, relative to the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
Management and mitigation measures	No change from the approved project.	No additional measures required.	Y	Y	

12. Consistency with the Approved Project

Based on a review and understanding of the existing Approved Project and the proposed modifications, is there is a transformation of the Project?	No. The proposal would not transform the project. The project would continue to provide major civil works between Westmead and The Bays as part of the approved project.
Is the project as modified consistent with the objectives and functions of the Approved Project as a whole?	Yes. The proposal would be consistent with the objectives and functions of the approved project.
Is the project as modified consistent with the objectives and functions of elements of the Approved Project?	Yes. The proposal would be consistent with the objectives and functions of the approved works for the project. The activities proposed to be undertaken are generally consistent with the activities identified for the approved project.
Are there any new environmental impacts as a result of the proposed works/modifications?	No. There would be no new environmental impacts as a result of the proposal. Some additional receivers may be impacted during the construction of the discharge line however these impacts would be relatively short in duration. All impacts identified for the approved project and the proposed works would be adequately addressed through the application of the mitigation measures provided in the Environmental Impact Statement, Submissions Report, Amendment Report and the Instrument of Approval.
Is the project as modified consistent with the conditions of approval?	Yes. The proposal would be consistent with the conditions of approval.
Are the impacts of the proposed activity/works known and understood?	Yes. The impacts of the proposal are understood and will be accounted for by implementing the existing mitigation measures provided in the Environmental Impact Statement, Submissions Report, Amendment Report and the Instrument of Approval for the approved project. These would be implemented through the Sydney Metro Construction Environment Management Framework, Construction Traffic Management Framework and Construction Noise and Vibration Standard, as well as the CEMP and CEMP sub-pans.

Are the impacts of the proposed activity/works able to be managed so as not to have an adverse impact?	Yes. The impacts of the proposal can be managed to avoid an adverse impact.

13. Other Environmental Approvals

Identify all other approvals required for the project:	• Road Occupancy License (ROL) will be obtained for all works on or adjacent to roads. • Approval for works that are required outside of approved construction hours (i.e., OOHW) will be sought in accordance with Condition D37 and/or D38 of the Instrument of Approval. • Road Opening Permit (ROP) will be obtained for trenching works. • Temporary Road Occupancy (TRO) approval will be obtained for temporary occupancy of the road and footpath along George Street. • EPL no. 21676 includes new discharge limits, monitoring points, and other any other conditions as required by the EPA. • City of Parramatta Council approval is required to use the existing stormwater drainage pit.

Author certification

To be completed by person preparing checklist.

I certify that to the best of my knowledge this Consistency Checklist: • **Examines and takes into account the fullest extent possible all matters affecting or likely to affect the environment as a result of activities associated with the Proposed Revision; and** • **Examines the consistency of the Proposed Revision with the Approved Project; is accurate in all material respects and does not omit any material information.**			
Name:	Candice Somerville	Signature:	
Title:	Environmental Approvals Manager		
Company:	Gamuda Lang O'Rouke Consortium	Date:	7 June 2023

This section is for Sydney Metro only.

Application supported and submitted by			
Name:	Yvette Buchli	Date:	08/06/2023
Title:	Director - Planning Approvals	Comments:	
Signature:	Yvette Buchli		

Based on the above assessment, are the impacts and scope of the proposed activity/modification consistent with the existing Approved Project?

Yes	The proposed activity/works are consistent, and no further assessment is required.
No	The proposed works/activity is not consistent with the Approved Project. A modification or a new activity approval/ consent is required. Advise Project Manager of appropriate alternative planning approvals pathway to be undertaken.

Endorsed by			
Name:	Ben Armstrong	Date:	14 June 2023
Title:	Director, Project ESP	Comments:	
Signature:	B. [signature]		

Appendix A – Heritage Assessment

Sydney Metro West

Parramatta Station Construction Site

Parramatta Water Treatment Plant Discharge Line

Archaeological Assessment

May 2023

GML HERITAGE

Acknowledgement of Country

We respect and acknowledge the First Nations of the lands and waterways on which we live and work, their rich cultural heritage and their deep connection to Country, and we acknowledge their Elders past and present. We are committed to truth-telling and to engaging with First Nations to support the protection of their culture and heritage. We strongly advocate social, cultural and political justice and support the Uluru Statement from the Heart.

Cultural warning

Aboriginal and Torres Strait Islander readers are advised that this report may contain images or names of First Nations people who have passed away.

GML HERITAGE

Report register

The following report register documents the development of this report, in accordance with GML's Quality Management System.

Project	Issue No.	Notes/Description	Issue Date
21-0167G	1	Draft Report	27 October 2022
21-0167G	2	Draft Report—revised study area	28 March 2023
21-0167G	3	Final Report	6 April 2023
21-0167G	4	Revised Final Report—minor revisions to proposed works.	21 April 2023
21-0167G	5	Revised Final Report—minor revisions	26 April 2023
21-0167G	6	Revised Final Report—minor revisions following review by Sydney Metro	15 May 2023

Quality management

The report has been reviewed and approved for issue in accordance with the GML quality management policy and procedures.

It aligns with best-practice heritage conservation and management, *The Burra Charter: the Australia ICOMOS Charter for Places of Cultural Significance, 2013* and heritage and environmental legislation and guidelines relevant to the subject place.

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Executive summary

Proposed works

The concept and major civil construction between Westmead and The Bays (Stage 1 of the planning approval process for Sydney Metro West) were approved as a State Significant Infrastructure project (SSI-10038) on 11 March 2021. The Western Tunnelling Package (WTP) works are being undertaken by Gamuda Laing O'Rourke Consortium (GLC). GLC is proposing to install a purpose-built discharge line for the Parramatta station construction site water treatment plant. Most of the proposed route for the discharge line is located along George Street (between Horwood Place and Charles Street) and is outside of the project boundary.

Assessment findings

This archaeological assessment has identified that the section of the study area within the approved project boundary has potential for localised areas to contain remnant Parramatta Sand Body deposits with a low to moderate potential for Aboriginal objects. This section of the study area also has a moderate potential for non-Aboriginal (historical) archaeological remains, including remains associated with two historical allotments on Macquarie Lane and Horwood Place. There is a moderate potential for historical archaeological remains associated with former convict allotments within Horwood Place. These potential archaeological remains would be managed in accordance with the ARDEM 2021 and AHR 2021.

The section of the study area outside the approved project boundary has potential for localised areas to contain remnant Parramatta Sand Body deposits with a low to moderate potential for Aboriginal objects. This section also has a low potential for historical archaeological remains, including historical road infrastructure. Trenching in these areas have low to moderate potential for direct impact on Aboriginal and historical remains where archaeological remains are present within the trench footprint.

The discharge line intersects with the alignment of the heritage listed Parramatta Town Drain (also known as the Convict Drain) (Parramatta Local Environment Plan Item No. I647) on George Street. As part of works to locate the Town Drain a 200mm diameter conduit was installed above the Town Drain to facilitate installation of the discharge line without the requirement for further excavation. This work was undertaken in compliance with 'GLC12_Environmental Review—Parramatta WTP Discharge Route—NDD' (endorsed by Sydney Metro on the 2nd February 2023). The proposed discharge line construction methodology would not result in impacts to the heritage-listed Town Drain.

Recommendations

- Archaeological monitoring of areas along Macquarie Lane, Horwood Place and George Street is recommended during construction to manage and mitigate impacts to significant archaeological remains should they be present within the impact area.
  - Archaeological monitoring and localised salvage excavation of historical archaeological remains that will be impacted by the works should be carried out in accordance with the methodology set out in the ARDEM 2021.
  - If intact natural soil deposits (equal to or greater than $1m^2$ in area) are identified that will be impacted by the proposed works, Aboriginal archaeological testing should be carried out in accordance with the methodology set out in the AHR 2021.
- The proposed discharge line construction methodology should be followed to ensure that the proposed works do not impact the heritage listed Parramatta Town Drain. No further excavation above or around the Parramatta Town Drain should be undertaken.
- Where possible, to minimise the likelihood of impacts to potential archaeological remains the following is recommended:
  - Excavation should be within existing services trenches.

Contents

1 Introduction

1.1 Project overview

The concept and major civil construction between Westmead and The Bays (Stage 1 of the planning approval process for Sydney Metro West) were approved as a State Significant Infrastructure project (SSI-10038) on 11 March 2021. The Western Tunnelling Package (WTP) works are being undertaken by Gamuda Laing O'Rourke Consortium (GLC). GLC is proposing to install a purpose-built discharge line for the Sydney Metro West Parramatta station construction site water treatment plant. The proposed route for the discharge line is mostly located outside of the project boundary.

GML Heritage Pty Ltd (GML) has been engaged to prepare an Aboriginal and non-Aboriginal (historical) archaeological assessment to assess the impacts of the works. This report has been prepared to identify whether there is potential for Aboriginal and non-Aboriginal (historical) archaeological remains including the heritage listed Parramatta Town Drain along the proposed route and make recommendations regarding the management of the archaeological resource.

1.2 Study area

The proposed discharge line will run from the southeast corner of the Parramatta station construction site northwards along Macquarie Lane, west to the rear of The Roxy Theatre, continuing north along Horwood Place, and east along George Street, connecting to an existing stormwater drainage outlet which will discharge downstream of the Charles Street Weir into Parramatta River. Figure 1.1 shows the location of the study area in relation to the approved boundary for the Parramatta station construction site.

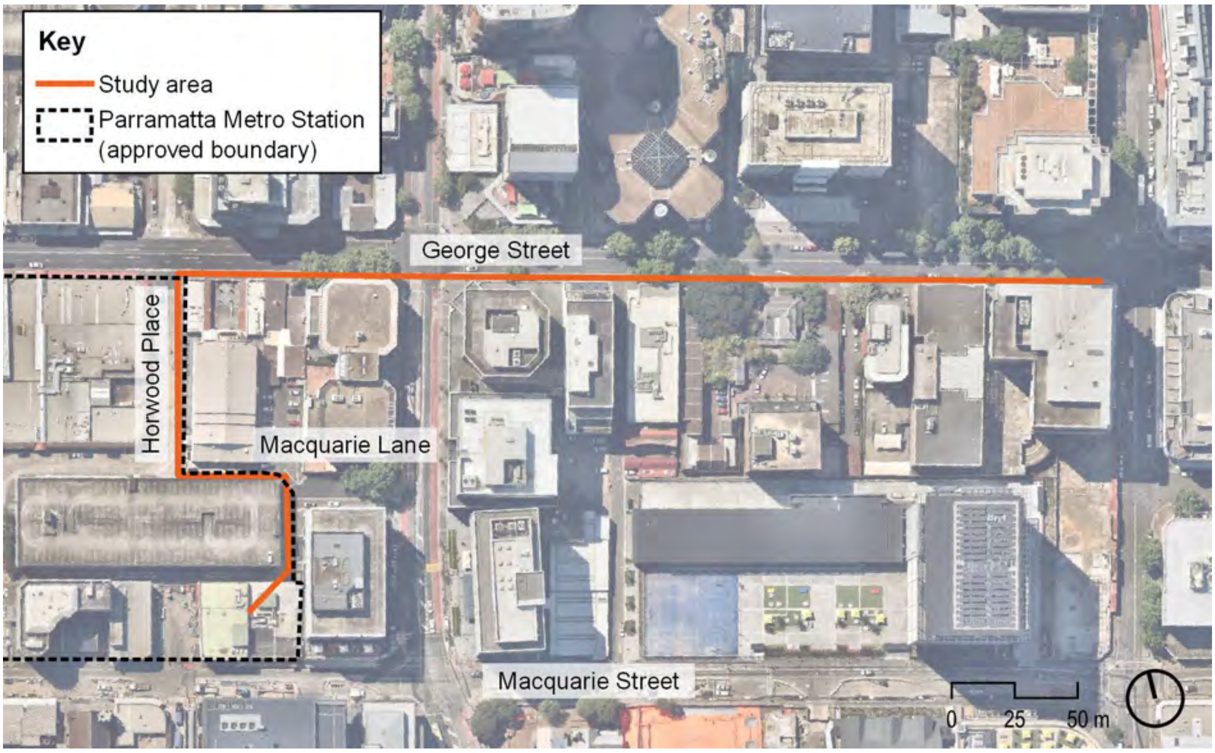


Figure 1.1 The study area showing the proposed water treatment plant discharge line route through the eastern half of the Parramatta station construction site and eastward along George Street to Charles Street. (Source: Nearmap with GML overlay, 2023)

1.3 Previous reports

The Aboriginal and non-Aboriginal heritage of the Parramatta station construction site has been considered in previous reports prepared for the Sydney Metro West project. These are:

- Sydney Metro West, Westmead to The Bays and Sydney CBD, Environmental Impact Statement, Concept and Stage 1—Chapter 12, Non-Aboriginal Heritage—Stage 1 (Non-Aboriginal Heritage EIS)
- Sydney Metro West, Westmead to The Bays and Sydney CBD, Environmental Impact Statement, Concept and Stage 1—Chapter 13, Aboriginal Heritage—Stage 1 (Aboriginal Heritage EIS)
- Sydney Metro West, Westmead to The Bays and Sydney CBD, Environmental Impact Statement, Concept and Stage 1—Technical Paper 3, Non-Aboriginal Archaeological Assessment, prepared by Artefact Heritage, April 2020
- Sydney Metro West, Westmead to The Bays and Sydney CBD, Environmental Impact Statement, Concept and Stage 1—Technical Paper 4, Aboriginal Cultural Heritage Assessment Report, prepared by Artefact Heritage, November 2020

- Sydney Metro West, Westmead to The Bays and Sydney CBD, Submissions Report, Concept and Stage 1—Appendix F, Non-Aboriginal Archaeological Research Design, prepared by Artefact Heritage, October 2020
- Sydney Metro West Parramatta Station Construction Site Archaeological Research Design & Excavation Methodology (ARDEM), prepared by GML Heritage, November 2021
- Sydney Metro West Parramatta Station Construction Site Aboriginal Heritage Report (AHR), report prepared by GML Heritage, October 2021.

1.3.1 Environmental Impact Statements

The project Environmental Impact Statement (EIS) included technical reports identifying the Aboriginal and non-Aboriginal heritage impacts for the Parramatta station construction site and project overall.

The Aboriginal heritage report determined that the project would have a direct impact on Aboriginal archaeological remains and recommended archaeological testing where intact natural profiles with potential for Aboriginal objects are found.

The Non-Aboriginal heritage report determined that the project would have a major impact on significant historical archaeological remains at the Parramatta station construction site. It identified minor impacts to the heritage listed Parramatta Town Drain, also known as the Convict Drain, (Parramatta Local Environment Plan No. I647) (resulting from accidental damage, and vibration).

1.4 Proposed works

The proposed works involve excavation of a trench to install a discharge line for the Parramatta station construction site water treatment plant. The discharge line will be installed around the eastern perimeter of the Parramatta station construction site, north along Horwood Place, and east along George Street between Smith Street and Charles Street.

1.5 Limitations

This report does not assess above-ground built heritage items.

1.6 Authorship

This report was prepared by Sophie Jennings (GML Associate) and Drew Kennedy (GML Graduate Heritage Consultant), and reviewed by Abi Cryerhall (GML Principal).

2 Aboriginal archaeology

This section presents the Aboriginal heritage assessment of the study area. It includes an extensive search of the Aboriginal Heritage Information Management System (AHIMS) database; targeted desktop review of background documentation; and assessment of the potential for Aboriginal archaeology within the study area. Reference should be made to GML's Aboriginal Heritage Report (AHR 2021) prepared for the Parramatta station construction site for further information.

2.1 Aboriginal Heritage Information Management System

A search of the Heritage NSW Aboriginal Heritage Information Management System (AHIMS) database was undertaken on 19 October 2022 (reference number 723963). A basic search conducted on 16 March 2023 confirmed no additional sites have been recorded within the study area (reference number 764281). The search covered a zone from eastings 315178, 315978 to northings 6256323, 6256763 with no buffer. The results of the search are shown in Table 2.1 and Figure 2.1. A total of 22 Aboriginal sites/places were identified.

Table 2.1 Results of AHIMS search.

Site Features	Frequency	Percentage
Artefact	2	9%
Artefact and PAD	2	9%
Artefact, Hearth, and PAD	1	4.5%
PAD	16	72.7%
Total	**22**	**100**

There are no registered AHIMS sites within the study area. Potential archaeological deposits (PADs) are the most common site type in the area. PAD sites make up all of the registered sites closest to the study area (45-6-28932, 45-6-3065, 45-6-4053, and 45-6-3582). Spatially there are three registered sites within 50m of the study area (45-6-2893, 45-6-4053, and 45-6-3065); all three of these sites are registered PADs—all of which are valid, open sites. There is a larger concentration of sites in the eastern half of the AHIMS search boundary, closer to Parramatta River. Of the 22 registered AHIMS sites, four have been destroyed and another three partially destroyed.

The frequency of PADs and stone artefact-based sites registered within the vicinity of the study area suggests that should Aboriginal objects be encountered within the study area, they would most likely be PADs or stone artefact site types.

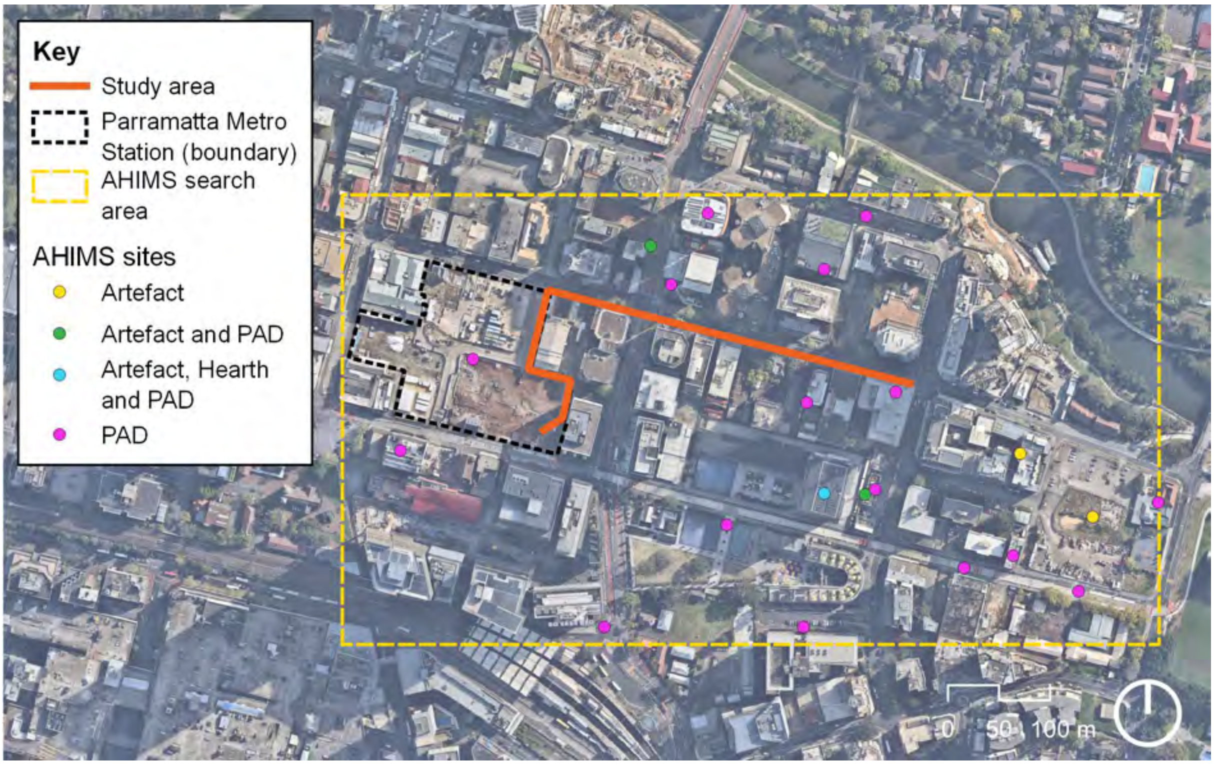


Figure 2.1 AHIMS search results. (Source: Nearmap 2022 with GML overlay)

2.2 Relevant local literature

In recent years, Aboriginal heritage, and sedimentary investigations within Parramatta have sought to understand the relationships between landforms, soil landscapes, and long-term trends in archaeological deposits. Many Aboriginal archaeological investigations have been carried out in Parramatta in recent years. These studies have demonstrated the potential for extensive Aboriginal archaeological sites, comprised predominantly of stone artefact sites, across the Parramatta CBD. Several excavations have also found stratified deposits within the Parramatta Sand Body (PSB). Below is a summary of several investigations of relevance to this assessment.

- Parramatta station construction site (GML 2022): a program of Aboriginal archaeological test excavation recovered low densities of Aboriginal objects across the station site. Post-excavation analysis is ongoing and will provide further information on the outcomes of this investigation.
- PSB, mapping by Mitchell (2008): [1] this report provides mapping for the extent of PSB and Birrong alluvium across Parramatta. The mapping is relatively accurate. This

report provides a reliable baseline for understanding the extent of the PSB today. It also includes an early interpretation of PSB formation, along with thermoluminescence dates for its formation.

- Arthur Phillip High School (APHS) and Parramatta Public School (PPS) Aboriginal Archaeological Post-Excavation Report: [2] this report provides the outcomes of the detailed archaeological investigations across land to the immediate east of the Sydney Metro Parramatta site. The work included excavations on Blacktown residual soil, Birrong alluvium and the PSB, which recovered stratified sequences of stone artefacts from all three soil landscapes. Two locations (on the PSB and residual soil landscapes) yielded post-1788 sites, with glass and flint artefacts. The report provides a detailed statistical analysis of lithics (stone artefacts) from many Aboriginal sites across Parramatta.
- Parramatta Light Rail, Aboriginal Archaeological Post-Excavation Report: [3] archaeological and sedimentary analysis for this project included testing soils and sediments along Church Street and Macquarie Street, Parramatta. The analysis and outcomes inform the precise nature of soils within the street corridors and can be extrapolated to the Sydney Metro site. The project data also includes additional geotechnical information, which underpins our analysis for the wider Sydney Metro site.
- Aboriginal Sites RTA GTC1 and CG1, post-excavation reporting: [4] these two archaeological excavation reports focus on the largest Aboriginal archaeological deposits within the PSB on the southern side of Parramatta River. Data from these sites on the nature, extent and age of Aboriginal archaeology within the PSB provides a baseline for the Parramatta CBD.
- White 2018: [5] this PhD thesis presents analysis of Aboriginal lithic sites across Parramatta and the wider Cumberland Plain. It establishes the chronology for Sydney's Aboriginal occupation and has been used as the baseline for studies in Parramatta.

2.3 Landscape context

The purpose of this section is to provide environmental contextual information for use in developing a predictive model of Aboriginal site locations within the study area. Interactions between people and their surroundings are of integral importance in both the initial formation and the subsequent preservation of the archaeological record. The nature and availability of resources, including water, flora and fauna, and suitable raw materials for the manufacture of stone tools and other items had—and continues to have—a significant influence over the way in which people use the landscape.

The study area overlies the PSB, a soil landscape unique to Parramatta (Figure 2.2). The PSB was formed through a combination of fluvial (water-moved) and aeolian (wind-deposited) clayey sands or sandy clays. This variability in formation processes is recognised in the distinction between three different profiles as shown in Figure 2.2. The western half of the study are overlies the Pleistocene or Tertiary Alluvium, an alluvial clay and sand deposit that is usually a dull yellow colour (Figure 2.3). The eastern half of the study area overlies the Pleistocene Terrace Sand, a clayey sand deposit that is usually a bright reddish orange colour (Figure 2.4).

Aboriginal people started living on the PSB around 40,000 years ago. The places they occupied contain evidence for stone artefacts, hearths, cooking pits and flat sandstone plates they transported into their living areas. The nature of the PSB varies across Parramatta in its appearance, hardness, depth and chemical composition.

The largest source of water in proximity to the study area is Parramatta River, which lies approximately 170m north of the study area (Figure 2.2). In the early Holocene period, Parramatta River was a freshwater stream; after the rise of sea levels approximately 7,000 years before present (BP) the river became partially tidal. The tidal limit is in the area of the Charles Street Weir. The circulation system of the estuary waters creates a diverse ecosystem, allowing a high growth rate for microscopic plants. The estuary is highly fertile and provides humans with aquatic flora and fauna resources that are not available in any of the surrounding landscapes. The range of accessible aquatic foods can depend on the fluctuation of tidal water.

The study area lies on the terrace above Parramatta River, at around 8–10m above Australian Height Datum (AHD). The land within Parramatta CBD is bisected by seasonal creeks and ponds, creating a gently undulating surface (Figure 2.2).

At Parramatta the range of ecological habitats would have been significant in the context of local Aboriginal economies. The freshwater and saltwater environments provided habitats for a significant variety of plant species, capable of supporting a wide range of both aquatic and terrestrial animals, birds, and other creatures.

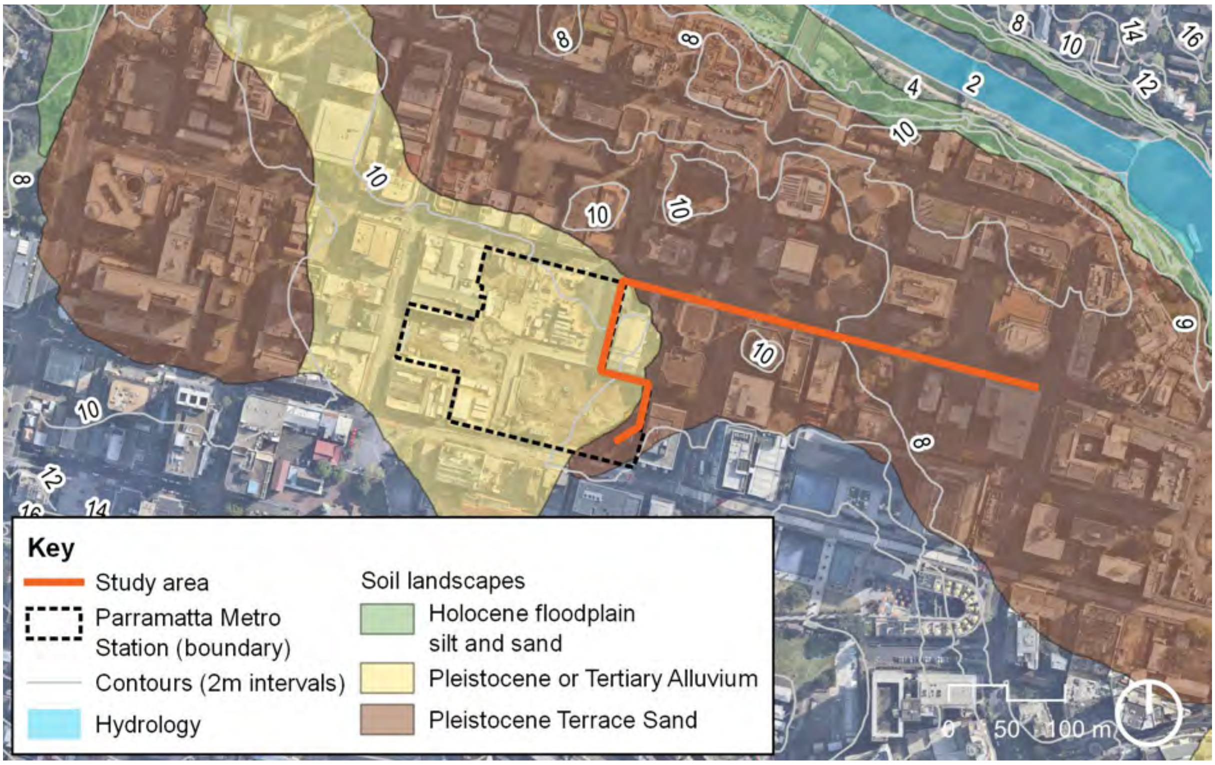


Figure 2.2 Landscape context of the study area. (Source: Nearmap 2022 with GML overlay)

Figure 2.3 Example of the PSB Pleistocene or Tertiary Alluvium excavated at Parramatta Square. (Source: Lawrie 2019 [6])

Figure 2.4 Example of the PSB Pleistocene Terrace Sand excavated at Cumberland Hospital as part of the Parramatta Light Rail project.

2.4 Study area analysis

The level of disturbance and resulting archaeological sensitivity varies across the study area. Modern developments, in particular construction of the roads and installation of services, have had a major impact on the study area. A Before You Dig search undertaken on 21 October 2022 showed several services passing through the study area, including electricity, water, stormwater, sewerage, and telecommunications assets, along Macquarie Lane, Horwood Place and George Street roads and footpaths.

The section of the study area at the rear of the Roxy Theatre (between Horwood Place and Macquarie Lane) has been impacted by construction for the Parramatta station construction site enabling works and has no archaeological potential.

There is potential for localised areas along the study area to retain intact soil profiles that may contain Aboriginal objects.

2.5 Predictive modelling

Aboriginal archaeological material ('objects') are not dispersed evenly across the wider landscape. The distribution of cultural material depends on numerous factors including preservation conditions, and environmental and landscape factors. The study area sits on a terrace landform, situated on the southern banks of Parramatta River. The study area has a low relief of 2m with a slope of <1%. The review of the landscape context shows that the study area is in close proximity to fresh drinking water and abundant food and medicinal resources. The pattern that becomes evident when looking at the registered AHIMS sites is that most are in close proximity to Parramatta River; proximity to a water source is common among Aboriginal sites.

The frequency of PADs and stone artefact sites returned in the AHIMS search area and in the vicinity of the study area suggests that should Aboriginal objects be encountered in the study area, they would most likely be PADs, artefact scatters or isolated artefacts. A hearth is registered approximately 126m south of the study area. Although this is the only one registered in the area, hearths are commonly found along river and creek beds, so others might also be present. If intact PSB deposits are encountered, they could potentially contain stratified archaeological deposits.

The results of this desktop assessment indicate that there is potential for localised areas in the study area to contain remnant PSB deposits, and there is a low to moderate potential for the presence of Aboriginal objects in these deposits.

2.6 Endnotes

[1] Mitchell, P B, 'Nature and Distribution of Parramatta Terrace Sand', report prepared for Parramatta City Council, May 2008.

[2] GML Heritage 2021, 'Arthur Phillip High School and Parramatta Public School Aboriginal Archaeology Post-Excavation Report', prepared for SINSW and DET.

[3] GML Heritage, in preparation, 'Parramatta Light Rail, Aboriginal Archaeological Post Excavation Report', for Parramatta Connect and TfNSW.

[4] JMcDCHM, 'Archaeological Salvage Excavation of Site CG1 at the Corner of Charles and George Streets, Parramatta, NSW', report prepared for Meriton Apartments Pty Ltd, January 2005.

JMcDCHM, 'Archaeological Salvage Excavation of Site RTA-G1, 109–113 George Street, Parramatta, NSW', report prepared for Landcom, October 2005.

[5] White, E 2018, 'Time matters on shallow open sites: An example from Western Sydney, Australia', unpublished Doctor of Philosophy thesis, University of Sydney, Sydney.

[6] Lawrie, R, 2019. Soil properties at archaeological site, Parramatta Square PS2, 160–180 Church Street, Parramatta. Report prepared for Comber Consultants. Page 1 and Figure 1.

3 Historical archaeology and the heritage listed Parramatta Town Drain

This section presents the historical archaeology assessment of the study area. It also includes an assessment of potential impacts on the Parramatta Town Drain (Parramatta LEP item no. I647), which is a subterranean or buried heritage item that is treated as a historical archaeological item. This section contains a summary history of the study area and a review of key historical maps and plans and previous archaeological investigations within and adjacent to the study area. This information is used to inform an assessment of the historical archaeological potential of the study area and its significance.

3.1 Historical overview

A detailed history of Parramatta is presented in the ARDEM 2022. The following section provides a brief overview of the development of the study area.

The study area is in the historic core of Parramatta. George Street, originally High Street, was one of the first streets laid out for the township of Parramatta (Figure 3.1). The western part of the study area was within allotments laid out for convict accommodation. The 1792 plan shows the study area overlapping through three allotments (Figure 3.1). By 1804 the town had expanded and allotment boundaries were shifted; the study area then passed through one allotment on Macquarie Street and two allotments on George Street (Figure 3.2).

As more free settlers and emancipists came to Parramatta, the town's layout was transformed, and land was subdivided and built on in an irregular fashion. To manage this process, property ownership and tenure were formalised in the early 1820s and allotments were allocated a section and lot number, as recorded on the 1823 plan (Figure 3.3). The western part of the study area passes through three allotments, lots 74, 28 and 17 in Section 16. The 1823 plan also shows the creation of new streets, including Smith Street, which Lot 28 faces.

The arrangement of streets and property boundaries remained largely unchanged for the rest of the nineteenth century and into the twentieth century. The 1844 plan shows a new building added to Lot 17, which the study area overlaps (Figure 3.4). The 1895 plan shows the study area overlapping an outbuilding on Lot 74 (Figure 3.5). It also shows that Lot 17 had been subdivided and that the study area passed along the boundary between the two lots, close to two buildings (Figure 3.6).

The southern side of George Street between Horwood Place and Charles Street does not appear to have undergone any major alterations with regard to property boundaries during this period. The route of the private tramway that operated between Duck River and Parramatta Park is shown on the 1895 plan to the north of the study area (Figure 3.5).

A 1943 aerial photograph shows that the buildings in the western half of Lot 17 had been removed and this area was vacant land and used as an informal carpark (Figure 3.6). The Roxy Theatre had been built in the eastern half of Lot 17 by this date. The southern part of the study area is situated in the rear yards of properties in lots 74 and 28. By 1961 Horwood Place had been laid out, connecting Macquarie Street and George Street. The rear yards in Lot 28 had been removed and the area converted into a carpark.

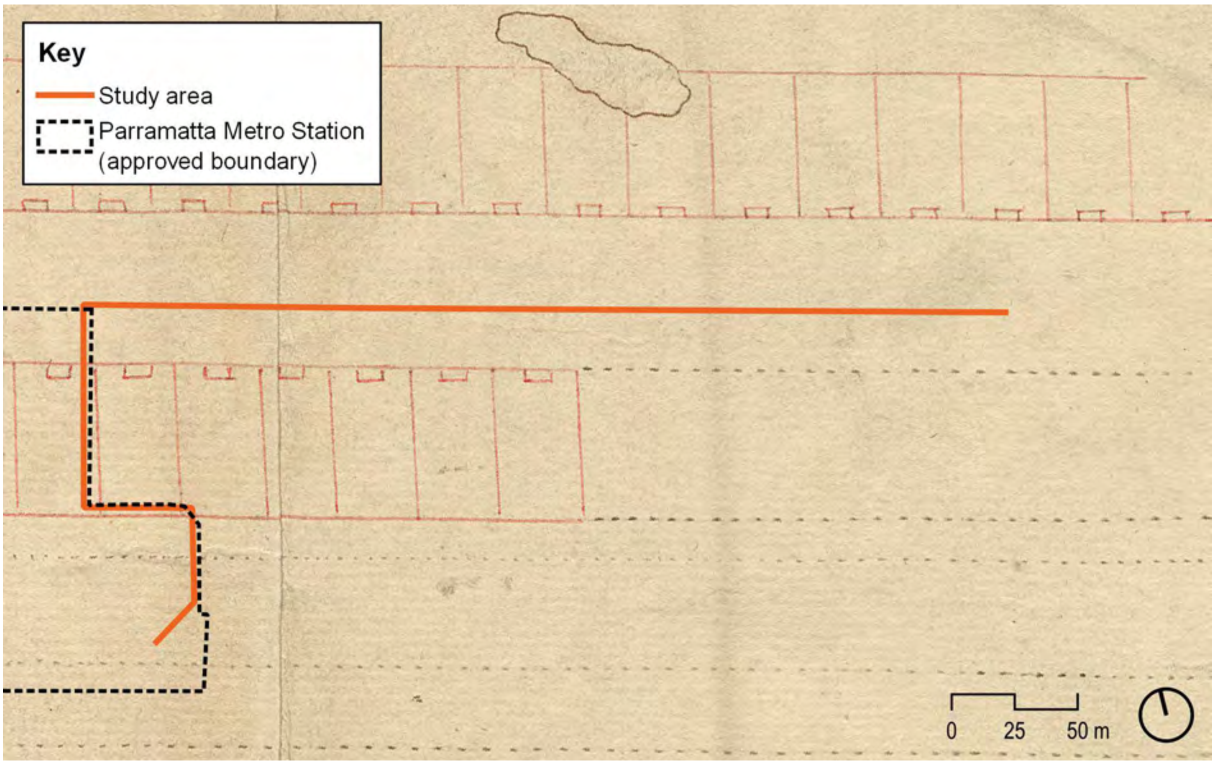


Figure 3.1 Detail from a plan of Parramatta c1790–92, showing the study area passing through two allotments on George Street. (Source: The National Archives (UK) CO/700/New South Wales 4 with GML overlay)

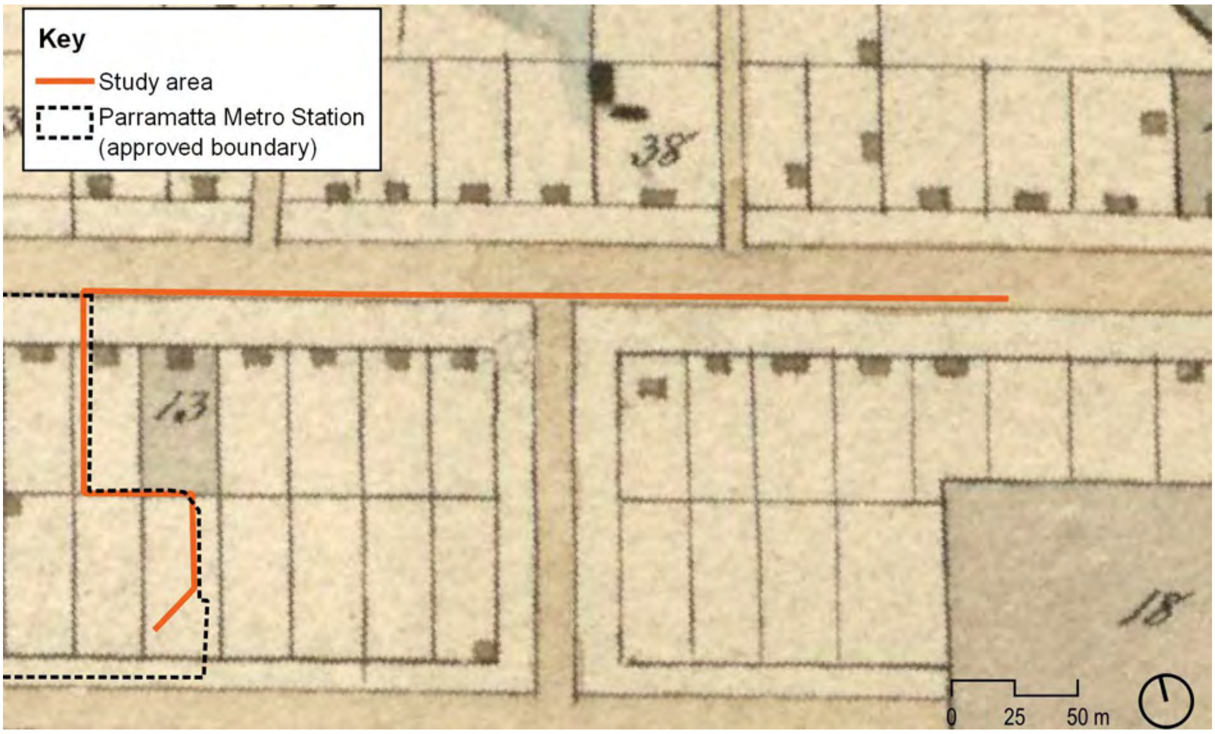


Figure 3.2 Detail from a plan of Parramatta by GW Evans, 1804. (Source: The National Archives (UK) CO/700/New South Wales 22 with GML overlay)

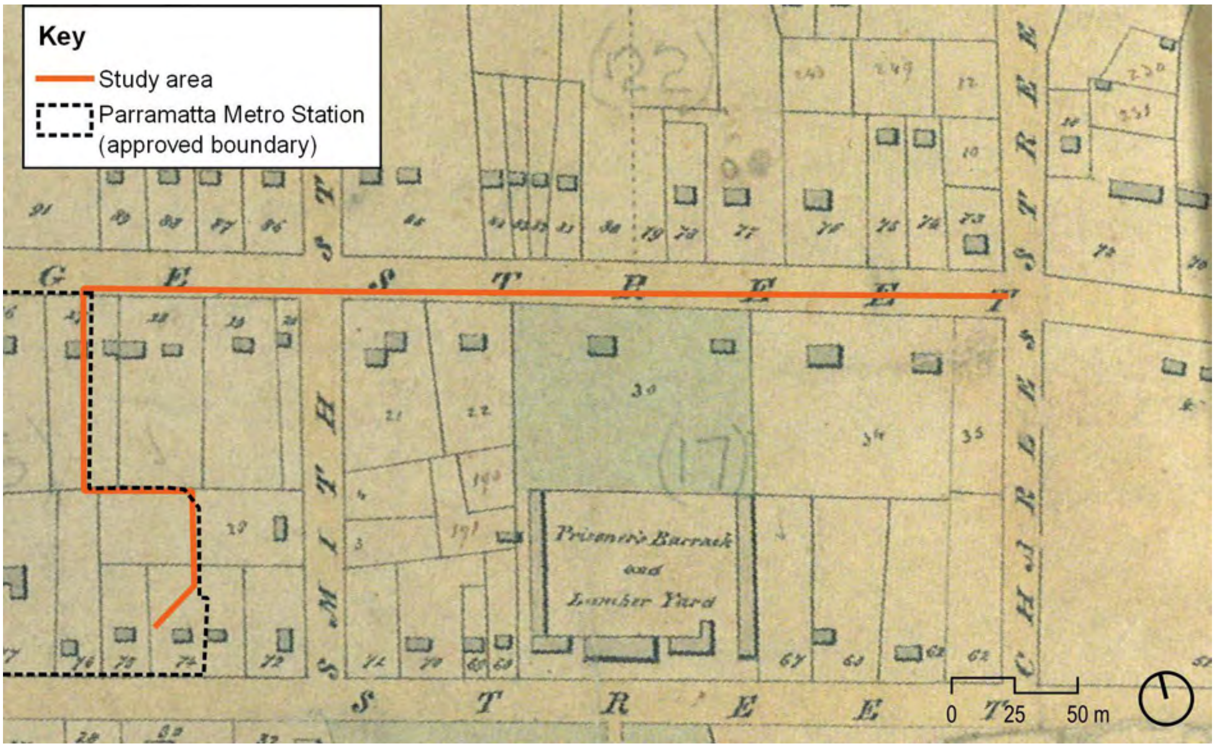


Figure 3.3 Detail from Stewart's 1823 plan of Parramatta. (Source: NSW State Archives and Records 4907 with GML overlay)

Figure 3.4 Detail from Brownrigg's 1844 plan of Parramatta. (Source: State Library of NSW (SLNSW) M4 811.1301/1844/1 with GML overlay)

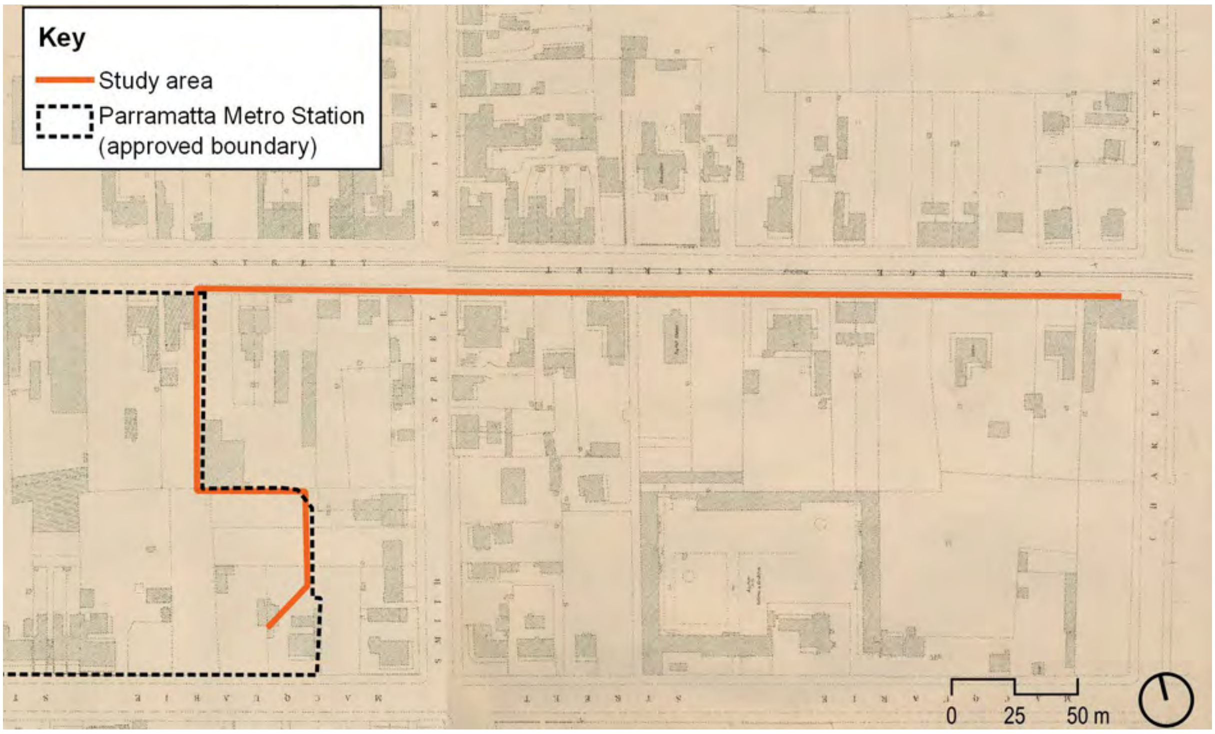


Figure 3.5 Detail from the 1895 Parramatta Detail Series (sheets 11, 18 and 19). (Source: State Library of NSW M Ser 4 811.1301/1 with GML overlay)

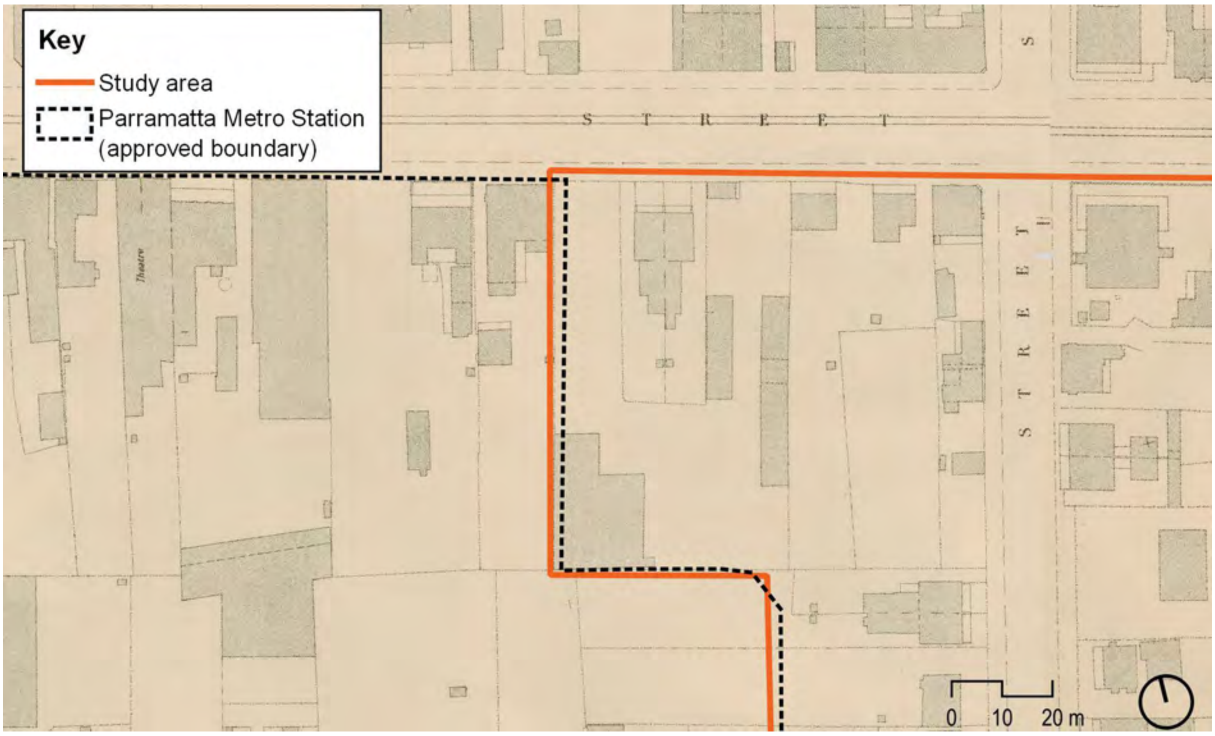


Figure 3.6 Detail from the 1895 Parramatta Detail Series (sheets 11, 18 and 19) showing where the study area passes along the boundary between properties on Lot 17 (now Horwood Place). (Source: State Library of NSW M Ser 4 811.1301/1 with GML overlay)

Figure 3.7 1943 aerial photograph showing the study area. (Source: SIX Maps with GML overlay)

3.2 Relevant archaeological studies

Findings from previous archaeological investigations in the vicinity of the study area have informed this assessment. These are outlined below.

3.2.1 Sydney Metro Parramatta, Enabling Works Archaeological Investigations

GML has recently completed a program of archaeological investigation for the enabling works stage of the Parramatta station construction site. The investigation found extensive archaeological remains below the modern ground surface at 74 Macquarie Street (Lot 74) and below the multistorey carpark adjacent to Macquarie Lane (western half of Lot 28). Archaeological clearance has been provided for the southern part of 74 Macquarie Street, excluding the Parramatta Town Drain, and the western half of Lot 28 excluding Macquarie Lane. The results of this investigation demonstrate the high potential for archaeological remains to survive below Macquarie Lane.

3.2.2 Parramatta Square Trunk Sewer, 70 Macquarie Street and Macquarie Lane

Casey & Lowe undertook archaeological monitoring and localised archaeological salvage excavation along the route of the trunk sewer that runs through 70 Macquarie Street and the eastern part of Macquarie Lane. [1] The sewer was installed through a combination of excavated trenches and underboring, with 16 trenches subject to archaeological investigation. Two of these trenches were close to the study area in Macquarie Lane. In TT10, levelling fills and modified topsoil was encountered below the road surface. In TT11, a sandstone footing and sandstock brick pad were found immediately below the road surface.

3.2.3 Parramatta Light Rail, Stage 1

GML completed a program of archaeological investigation as part of the Parramatta Light Rail project from 2020 to 2022. [2] A large portion of the works was carried out within the roadways of Parramatta and finds included historical road infrastructure (former road surfaces, drains) and remains of buildings demolished during road-widening events below the modern road surfaces and footpaths. The project demonstrated the potential for archaeological remains to survive, albeit fragmentary, within the roads and footpaths of Parramatta (Figure 3.8).

Figure 3.8 Example of truncated Telford Road surface showing the stone pitchers or setts on Church Street. Scale is 1 metre.

3.3 Parramatta Town Drain (Convict Drain)

The Parramatta Town Drain, also known as the Convict Drain, was constructed to aid drainage of water runoff from the surrounding high ground on the southern side of the early town of Parramatta. The Parramatta Town Drain is a locally listed heritage item (I647) on the Parramatta Local Environment Plan (Parramatta LEP). It was constructed in sections from the 1820s until the 1840s. The earlier section of the drain lay closer to Parramatta River, roughly north of George Street, and was constructed as a brick barrel-vaulted oviform drain in the 1820s. The later extension south of George Street was a sandstone box drain that appears to have been constructed c1840–1841. A section of the Town Drain was uncovered during archaeological excavations on the Parramatta Station site as part of the early works program at 74 Macquarie Street (Lot 74) (Figure 3.9).

The study area crosses the predicted alignment of the Town Drain on George Street (outside 85 George Street) (Figure 3.10). One of the Conditions of Approval (CoA), Condition D15, requires that all options must be considered to retain the Town Drain in situ. If retention in situ is not feasible, it must be demonstrated to the Planning Secretary why its removal is appropriate.

GLC undertook Non-Destructive Digging (NDD), with archaeological monitoring by GML, to confirm the location and survival of the Town Drain in George Street where it is crossed by the proposed discharge line. The archaeological monitoring exposed two rows of machine-made cored bricks orientated north–south on the predicted alignment of the drain (Figure 3.11). Visual inspection through a stormwater grate next to the trench confirmed the survival of the original section of the town drain immediately to the north and showed that the bricks exposed in the excavation trench were in line with the original drain. A memo on the results of the archaeological monitoring is provided as Appendix 1.

As part of the works to locate the Town Drain, a 200mm diameter conduit was installed above the Town Drain (Figure 3.12). The purpose of the conduit is to allow for installation of the discharge line without the need for further excavation above the Town Drain, thereby minimising the risk of impacts. This work was undertaken in compliance with 'GLC12_Environmental Review—Parramatta WTP Discharge Route—NDD' (endorsed by Sydney Metro on the 2nd February 2023).

Figure 3.9 Looking northeast along a section of the Parramatta Town Drain uncovered in the southeastern corner of the Parramatta Metro Station site during archaeological investigations as part of the early works program. Macquarie Lane is visible in the top left of the image.

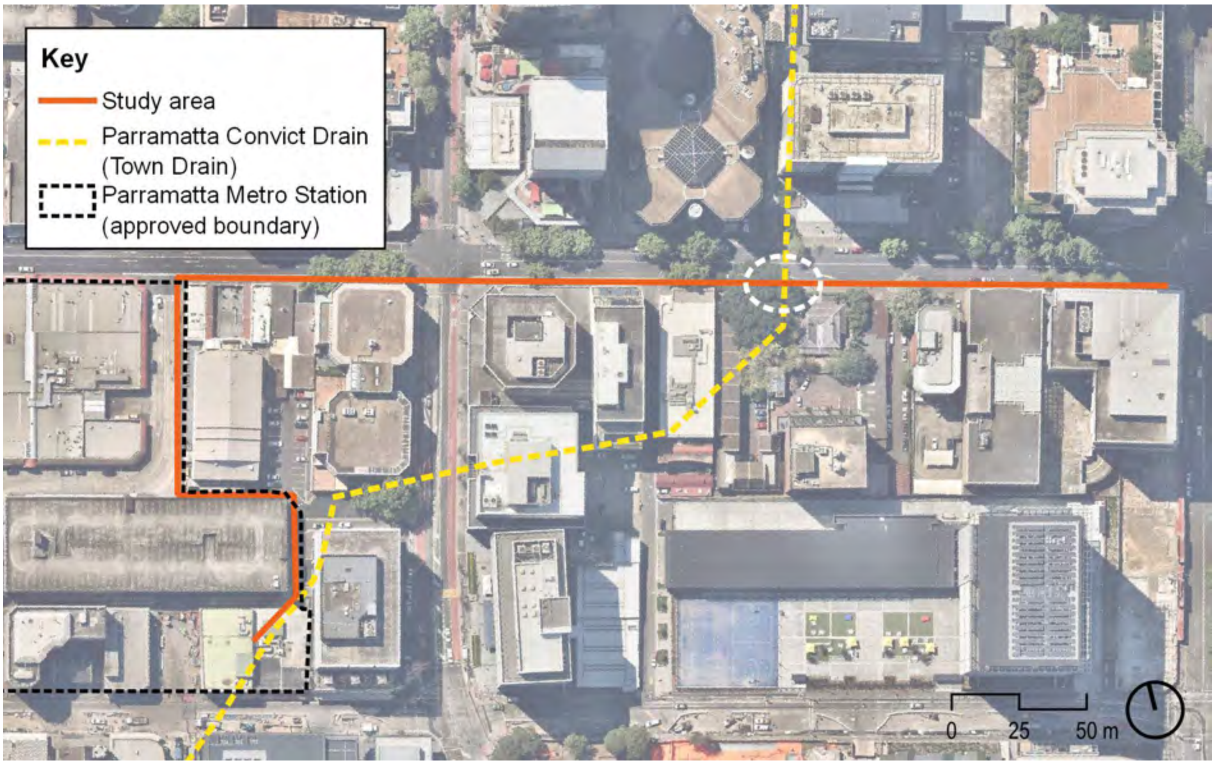


Figure 3.10 The location of the study area in relation to the route of the Parramatta Convict Drain (Town Drain). The point where the discharge line route crosses the Town Drain is circled in white. (Source: Nearmap 2023 with GML overlay)

Figure 3.11 Looking south at the two rows of bricks (arrow) that form part of the Town Drain, in front of 85 George Street Parramatta.

Figure 3.12 Looking south at conduit installed above the Town Drain.

3.4 Previous disturbance

Activities and development within the study area during the twentieth century and more recently may have affected the survival of archaeology and its integrity. The previous disturbances of the study area are discussed below.

The main impacts within the study area would have resulted from the construction of the existing roads surfaces and footpaths, and excavation for services (electricity, water, sewer, communications etc). A review of plans showing the locations of existing services was undertaken using the Before You Dig service (accessed on 21 October 2022). While the locations of the services are not provided in detail, the plans give general information that can be used to infer the likelihood of intact archaeological remains surviving within the study area.

The Before You Dig plans indicate there are few existing services in Macquarie Lane and at the rear of 74 Macquarie Street. An electrical service runs along the eastern side of Horwood Place within the footpath. Along the south side of George Street within the footpath there are multiple services, including water and electricity. The number of services identified on the Before You Dig plans suggests this section of the study area is likely to have been heavily impacted by excavation for existing service trenches.

The results of recent archaeological investigations (see Section 3.2) indicate the potential for archaeological remains to survive below the existing road and footpath surfaces. Construction of the road infrastructure, including grading of road surfaces and excavation for bedding layers, and kerbing stormwater etc, will have truncated or in places removed archaeological remains. However, there is potential for deeper features such as drains or deep cut features (wells, cesspits) to survive below these impacts.

3.5 Potential archaeological and heritage remains

Assessing the archaeological potential of an area is based on examining historical information related to the development and occupation of the study area, current conditions and previous disturbance, and comparable archaeological studies.

The ARDEM 2021 identified the following phases of historical development that are relevant in understanding the archaeological potential of the study area.

- Phase 1: Early colonial settlement (1788–c1820s)
- Phase 2: Leases and town development (c1820s–c1860s)
- Phase 3: Urbanisation and industry (c1860s–c1880s)
- Phase 4: Commercial development (c1880s–c1950s)
- Phase 5: Modern developments (c1950s–present).

3.5.1 74 Macquarie Street, Macquarie Lane and rear of Roxy Theatre

The southern part of the discharge line route and the section behind the Roxy Theatre are within areas that have been provided with archaeological clearance, and there is nil potential for archaeological remains within these areas (Figure 3.13).

Within Macquarie Lane there is a low potential for historical archaeological remains associated with undocumented ephemeral uses (cultivation, drainage and levelling, isolated rubbish dumping) from Phase 1. There is a moderate potential for archaeological remains associated with occupation of Lot 28 associated with phases 2–4. This could include remains associated with the buildings shown on the 1844 plan and 1895 plan such as undocumented structures, yard deposits, rubbish pits, cesspits and wells.

3.5.2 Horwood Place

There is moderate potential for historical archaeological remains associated with Phases 1–4 to survive below the existing footpath. Based on the 2021 ARDEM and the archaeological monitoring on George Street to locate the heritage listed Town Drain (Appendix A) archaeological remains may be present within 300–600mm of the surface.

There is a moderate potential for historical archaeological remains associated with the Phase 1 convict hut(s). Remains could include yard surfaces, rubbish pits, artefact scatters, wells, cesspits, and lot boundaries (postholes or ditches). There is also moderate potential for structural remains of buildings shown on the 1823 and 1844, and 1895 plans (Figure 3.3—Figure 3.5), as well as associated deposits and yard features such as a well, cistern, cesspits and rubbish pits.

3.5.3 George Street

There is a low potential for historical road infrastructure, such as earlier road surfaces and drains. Based on the 2021 ARDEM and the recent archaeological monitoring on George Street to locate the heritage listed Town Drain (Appendix A) archaeological remains may be present within 300–600mm of the surface. Archaeological remains are expected to survive in localised areas between modern impacts (service trenches). There is a known potential for remains of the heritage-listed Town Drain where it passes south to north across George Street outside 85 George Street (see Section 3.3).

3.5.4 Summary of archaeological potential

Table 3.1 Summary of historical archaeological potential within the study area.

Section	Phase	Potential archaeological remains	Potential
74 Macquarie Street, rear of Roxy Theatre	1–4	No potential within areas of previous archaeological investigations	Nil
Macquarie Lane	1	Cultivation, drainage and levelling, isolated rubbish dumping.	Low
	2–4	Structural remains, yard deposits, rubbish pits, cesspits, and wells.	Moderate
Horwood Place	1	Yard surfaces, rubbish pits, artefact scatters, wells, cesspits, postholes, or ditches.	Moderate
	2–4	Building footings (postholes, beam slots, sandstone or brick), occupation deposits, yard surfaces, rubbish pits, artefact scatters, wells or cisterns, cesspits.	Moderate
George Street	2–4	Former road surfaces, drains.	Low
	2	Town Drain.	Known

Figure 3.13 Historical archaeological potential along the study area. (Source: Nearmap 2022 with GML additions)

3.6 Assessment of archaeological and heritage significance

An assessment of the significance of the potential historical archaeological remains within the Parramatta Metro Station construction site is presented in the ARDEM 2021. The following assessment of archaeological significance is based on the ARDEM 2021; reference should be made to that report regarding the assessment criteria and levels of significance.

Archaeological evidence associated with the early nineteenth-century convict occupation could be of state significance depending on the integrity and intactness of any remains. The Parramatta Town Drain is of local significance as assessed in the ARDEM 2021.

Archaeological remains associated with the urban development of Parramatta from the early/mid to late nineteenth century would be locally significant for their historical, social and research values. This includes remains of the historical properties in Macquarie Lane and Horwood Place, and archaeological remains of historical road infrastructure.

3.7 Endnotes

1 Casey & Lower, 2021, 'Parramatta Square, Trunk Sewer—Preliminary Results Archaeological Report', report prepared for Walker Parramatta Square Developments on behalf of Sydney Water, May 2021

2 GML Heritage, 2022, 'Parramatta Light Rail, Infrastructure Works Package 4, Historical Archaeological Investigation Results, Volume 5.1—Drains, Roads and Buildings, Various HAMUs Main Report', report prepared for Parramatta Connect, June 2022.

4 Impact assessment

4.1 Proposed works

The proposed works are for the installation of a purpose-built discharge line for the water treatment plant to be constructed within the Parramatta Metro Station construction site.

The proposed works involve the following activities:

- service searches and validation;
- trenching through existing footpaths and roadways:
    - under the road surface level the trench will be excavated to a maximum of 0.8m. If services are encountered along the route excavation may need to extend to a maximum of 1.0m.
    - under the footpath surface level the trench will be excavated to a maximum depth of 0.5m. If services are encountered along the route, excavation may need to extend to a maximum depth of 0.6m.
    - along George Street the trench will be excavated, where possible, within the footprint of an existing sewer line that runs along the centre of the road;
- installation of one 150mm high-density polyethylene (HDPE) or poly pipe in the trenches;
- backfill of trenches using stabilised sand; and
- connection of HDPE pipes to existing stormwater drainage pit on George Street.

4.2 Impacts of proposed works

4.2.1 Works within the approved construction boundary

The section of the study area within the approved construction boundary has been assessed as having low to moderate potential to contain Aboriginal objects where remnant intact soil profiles survive. If present, remnant intact soils with the potential to contain Aboriginal objects will be impacted by the works within the trench footprint. This section of the study area also has a moderate potential for historical archaeological remains. Excavation for the discharge line trench would have a localised impact, removing any historical archaeological remains that may be present within the trench footprint where this is excavated outside of existing service trenches.

4.2.2 Works outside the approved construction boundary

Outside the approved project boundary, the study area has been assessed as having a low to moderate potential to contain Aboriginal objects where remnant intact soil profiles survive. Where the trenching works along George Street are within an existing service trench, this work is unlikely to impact Aboriginal objects as excavation for the existing trench will have removed any remnant intact soil profiles. If present, remnant intact soils with the potential to contain Aboriginal objects will be impacted by the trenching works where this extends outside the footprint of existing service trenches. Excavation for the discharge line trench would also have a localised impact on any historical archaeological remains that may be present within the trench footprint where this is excavated outside of existing service trenches or other previously impacted areas.

Service searching and activities involving non-destructive digging (NDD) may result in impact to archaeological deposits if undertaken outside existing services alignments and previously impacted areas.

The proposed works would not have an impact on the Parramatta Town Drain as the discharge line would be installed through the conduit that has been laid above the Town Drain in George Street (refer to Section 3.3 and Appendix 1).

As discussed in section 1.3.1, the Aboriginal and non-Aboriginal heritage reports prepared as part of the project EIS have assessed that the project would have the following impacts:

- direct impact on Aboriginal archaeology;
- major impact on significant historical archaeological remains; and
- minor impacts (accidental damage, vibration) on the heritage-listed Parramatta Town Drain (No. I647).

In summary, the proposed works have low to moderate potential for direct impact on Aboriginal and historical archaeology outside the approved project boundary. The proposed works would not impact the heritage-listed Parramatta Town Drain (No. I647).

5 Conclusions and recommendations

5.1 Conclusions

- The study area has potential for archaeological deposits and features.
  - The section of the study area within the approved project boundary has a low to moderate potential for Aboriginal objects in areas of remnant soil deposits and a moderate potential for locally significant historical archaeological remains. There is low potential for state significant historical archaeological remains.
  - The section of the study area outside of the approved project boundary has a low to moderate potential for Aboriginal objects in areas of remnant soil deposits and a low potential for locally significant historical archaeological remains. There is low potential for state significant historical archaeological remains.
- The proposed works have potential to impact Aboriginal and historical archaeology if present within the alignment.
  - Service searches using NDD outside existing services alignments and previously disturbed areas have potential for localised impacts to archaeology.
  - Excavation for the discharge line trench would remove any Aboriginal and historical archaeological remains within the trench footprint where this is located outside of existing service trenches.
- The study area intersects with the alignment of the heritage listed Parramatta Town Drain on George Street.
  - Project approval does not include impact to the Town Drain.
  - The location of the Town Drain outside 85 George Street has been confirmed by the NDD investigation (under archaeological supervision).
  - A 200mm diameter conduit has been laid above the Town Drain to facilitate the installation of the discharge line without impacting the Town Drain.
  - The proposed works would not have an impact on the Town Drain.

5.2 Recommendations

- Archaeological monitoring of areas along Macquarie Lane, Horwood Place and George Street is recommended during construction to mitigate impacts to significant archaeological remains.

- Archaeological monitoring including localised salvage excavation of historical archaeological remains that will be impacted by the works should be carried out in accordance with the methodology set out in the ARDEM 2021.
- If intact soil deposits (equal to or greater than $1m^2$ in area) are identified that will be impacted by the proposed works, Aboriginal archaeological testing should be carried out in accordance with the methodology presented in the AHR 2021.

* The proposed discharge line construction methodology should be followed to ensure that the proposed works do not impact the heritage listed Parramatta Town Drain. No further excavation above or around the Parramatta Town Drain should be undertaken.
* Where possible, to minimise the likelihood of impacts to potential archaeological remains the following is recommended:
  - Excavation should be within existing services trenches.

6 Appendices

Appendix A

Memo on archaeological monitoring of the Parramatta Town Drain

Appendix B

Plan of proposed route

Appendix A

Memo on archaeological monitoring of the Parramatta Town Drain

To:	Adam Littler, Project Engineer, Gamuda Laing O'Rourke Consortium
From:	Jacob Gwiazdzinski
Date:	6 April 2023
Our Ref:	21-0167Galc3
Subject:	Archaeological monitoring results—Parramatta Town Drain, George Street Non-Destructive Digging (NDD) investigation along the proposed Parramatta station site water treatment plant discharge line

Introduction

Gamuda Laing O'Rourke Consortium (GLC) is proposing to install a purpose-built discharge line for the Parramatta station construction site water treatment plant along George Street. The proposed discharge line crosses the projected alignment of the Parramatta Town Drain—a heritage-listed item—at 85 George Street. GLC undertook site investigations to locate the Town Drain and inform the construction methodology and heritage impact assessment for the proposed works. GML Heritage (GML) was engaged to provide archaeological monitoring and advice during the site investigations. This memo presents the archaeological monitoring results from the investigation.

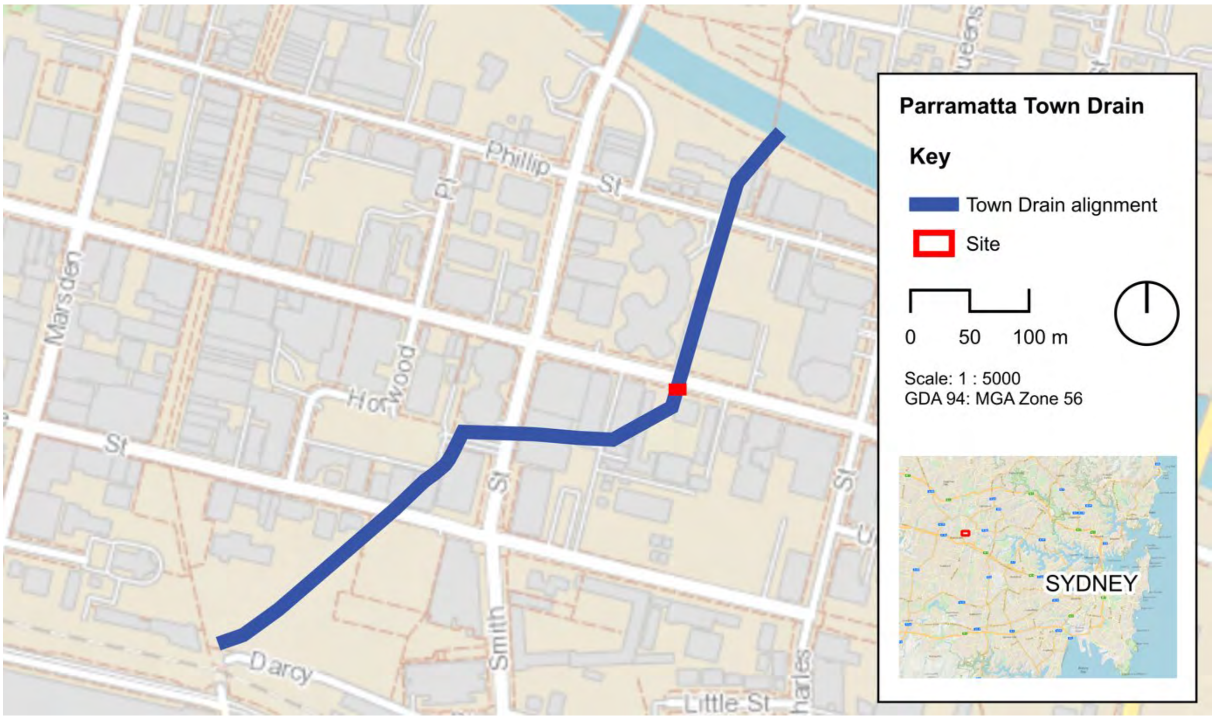


Figure 1 The Town Drain alignment and the location for the investigation site on George Street. (Source: Australian National Basemap with GML overlay)

The Parramatta Town Drain

The Parramatta Town Drain (also known as the Convict Drain) is a heritage item listed on the Parramatta Local Environment Plan (PLEP) as item no. I647. It was constructed in two main stages—the first in about 1820 and an extension to the south in 1841–42. It runs from Parramatta Square to Parramatta River and was constructed to aid drain water runoff from the surrounding high ground on the southern side of the early colonial town of Parramatta. The earlier section of the drain is a brick barrel drain and was recorded as being oviform at several archaeological sites on George and Smith Streets. This initial section was built by the colonial government using convict labour. The southern extension is a sandstone box drain and originally included open sections and capped sections.[1] At Parramatta Square an earlier timber-lined watercourse was found below the drain. The extension was built by the council using convicts from Parramatta Gaol. From the 1860s the open drain sections were capped. In the early twentieth century the capstones were replaced with concrete slabs. The drain has been subject to other modifications, repairs and impacts from services throughout the twentieth century. Many sections have been removed following archaeological investigations associated with redevelopments in recent years. It is no longer functional and it not part of the city's active stormwater system.

Investigation methodology

The location for the investigations was informed by previous advice prepared for GLC (GML memo dated 11 January 2022 ref 21-0167Gal2). The site was at the intersection of the proposed alignment for the conduit discharge line and the projected alignment of the Town Drain. A slot trench was saw-cut through the road verge and driveway for 85 George Street, measuring 5m across and 500mm wide to best determine the location of the drain.

Non-destructive digging (NDD) using a dry vacuum truck was employed to minimise the potential impact to existing services, the Town Drain and surrounding archaeology. The trench was excavated to a depth of RL 6.98m (145mm below the surface), where a reinforced concrete slab was encountered at the western end of the trench. In order to assess the thickness of the slab, a layer of builders sand in the area immediately east of the slab was excavated to a depth of RL 6.2m (600mm below the surface) where the base of the slab was encountered. Once the depth of the slab was determined, it was saw cut, broken up with an excavator and then removed. NDD excavation continued beneath the concrete slab to expose the top of two parallel rows of twentieth century bricks, which were cleaned and recorded and left in situ (see below for a detailed discussion of the find). This is approximately 1m east of the projected alignment which is shown in Figure 11. Immediately north of the trench was a modern stormwater grate in the gutter on George Street (Figure 10, Figure 11). The visual inspection confirmed that the modern stormwater truncated the section of the drain exposed within the trench. It also confirmed that a section of the sandstock brick barrel drain was connected to the modern stormwater and continued toward the north along the original known alignment (outside of the proposed route for the discharge line). A larger section of concrete above the brick alignment was removed within the saw-cut area of the trench to investigate any connection to a section of the drain with original fabric.

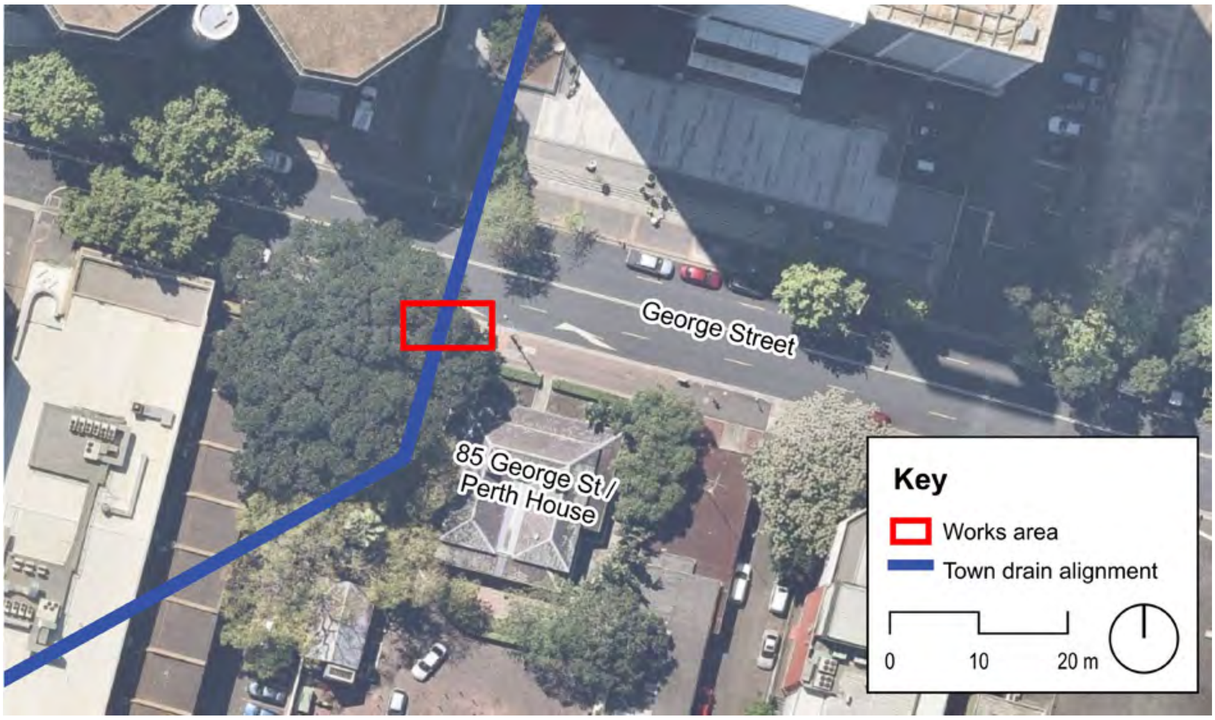


Figure 2 The location of site works in relation to the Town Drain alignment. (Source: Nearmap with GML overlay)

Investigation results

The investigation found two parallel rows of machine-made bricks on the alignment of the Town Drain. These have been interpreted as a later modification to the Town Drain based on its location and form. As the space between the bricks had been backfilled with redeposited topsoil mixed with clay, it was not possible to determine to what depth the drain survives or how it is connected to the original structure.

The top of the Town Drain (as later modified) was identified and recorded in the test trench. Recording included photography and survey to provide an orthophotograph and digital elevation model. A summary of the recorded characteristics is outlined in Table 1.

Once recording of the drain had been completed, a layer of sand was laid over the section of the drain exposed in the trench. The conduit pipe was then installed and the remainder of the trench was backfilled with sand. The verge and driveway were reinstated with asphalt.

Table 1 Summary of structural form and location information of the Town Drain at 85 George Street.

Form	Depth	Dimensions
Modern brick (interpreted as a 20^{th} century modification to the Town Drain)	400mm from surface RL: 6.6m	Height: unknown Width: 1.2m

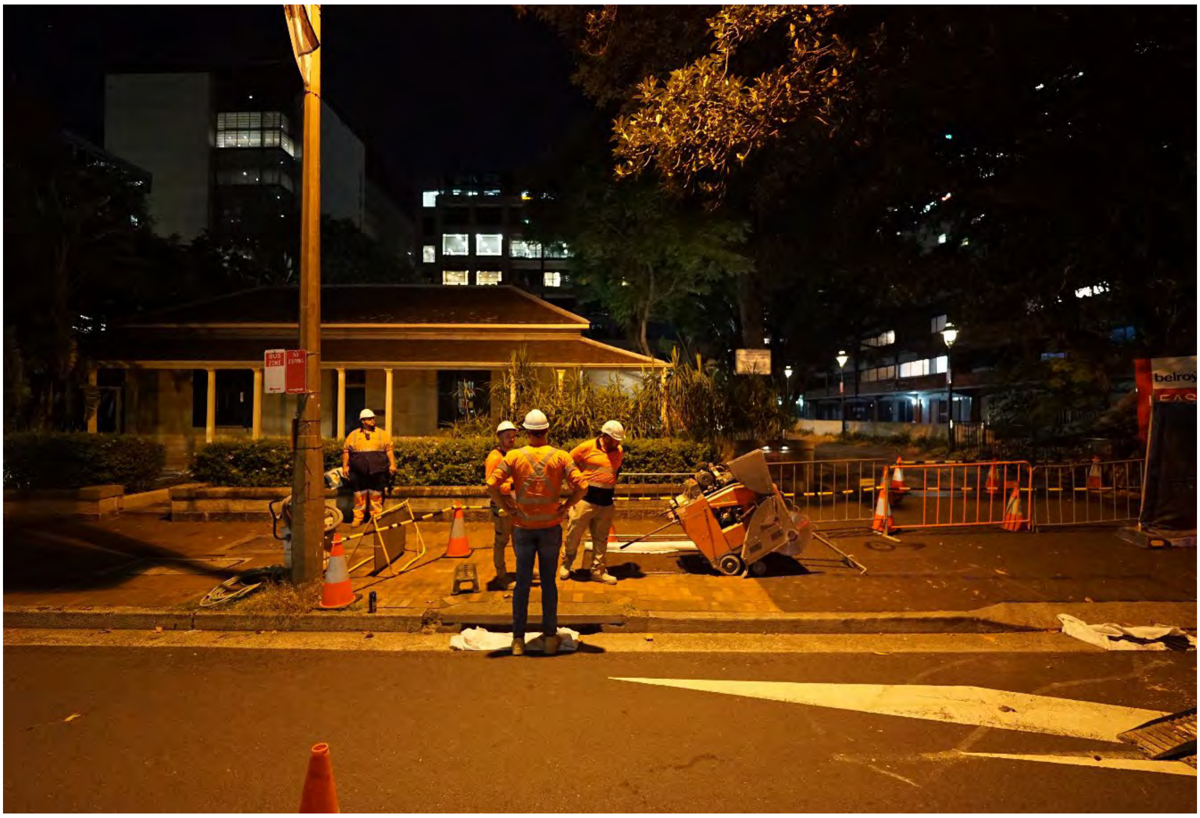


Figure 3 View south showing the location of works in relation to Perth House, 85 George Street.

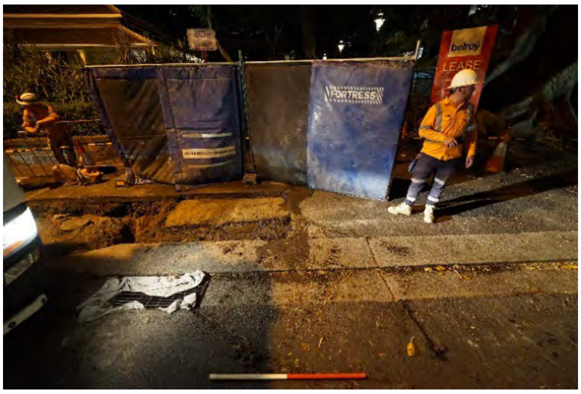


Figure 4 View south showing the removal of asphalt and exposed fills and concrete slab.

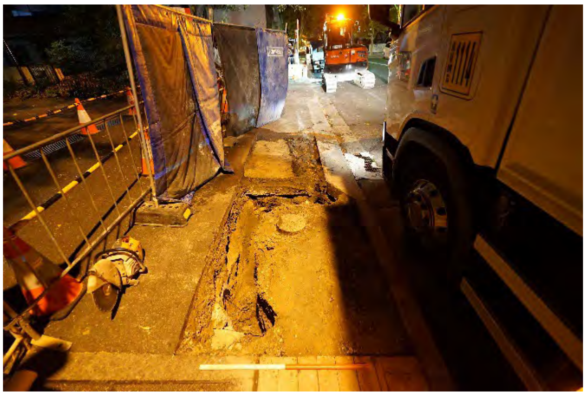


Figure 5 View west showing modern builder's sand fill in the foreground and an exposed concrete slab covering the modern section of the Town Drain in the background.

Figure 6 View north showing the Town Drain in relation to the modern stormwater grate.

Figure 7 View south showing the depth of the Town Drain beneath the modern surface.

Figure 8 View south showing a machine-made brick section of drain, filled with a modern mix of historic topsoil and clay to the west and within the drain, and builder's sand to the east.

Figure 9 View northeast showing the exposed section of Town Drain with c20th century associated fills.

Figure 10 View north showing a sandstock brick barrel section of drain toward Parramatta River, visible beneath the modern stormwater grate shown in Figure 9.

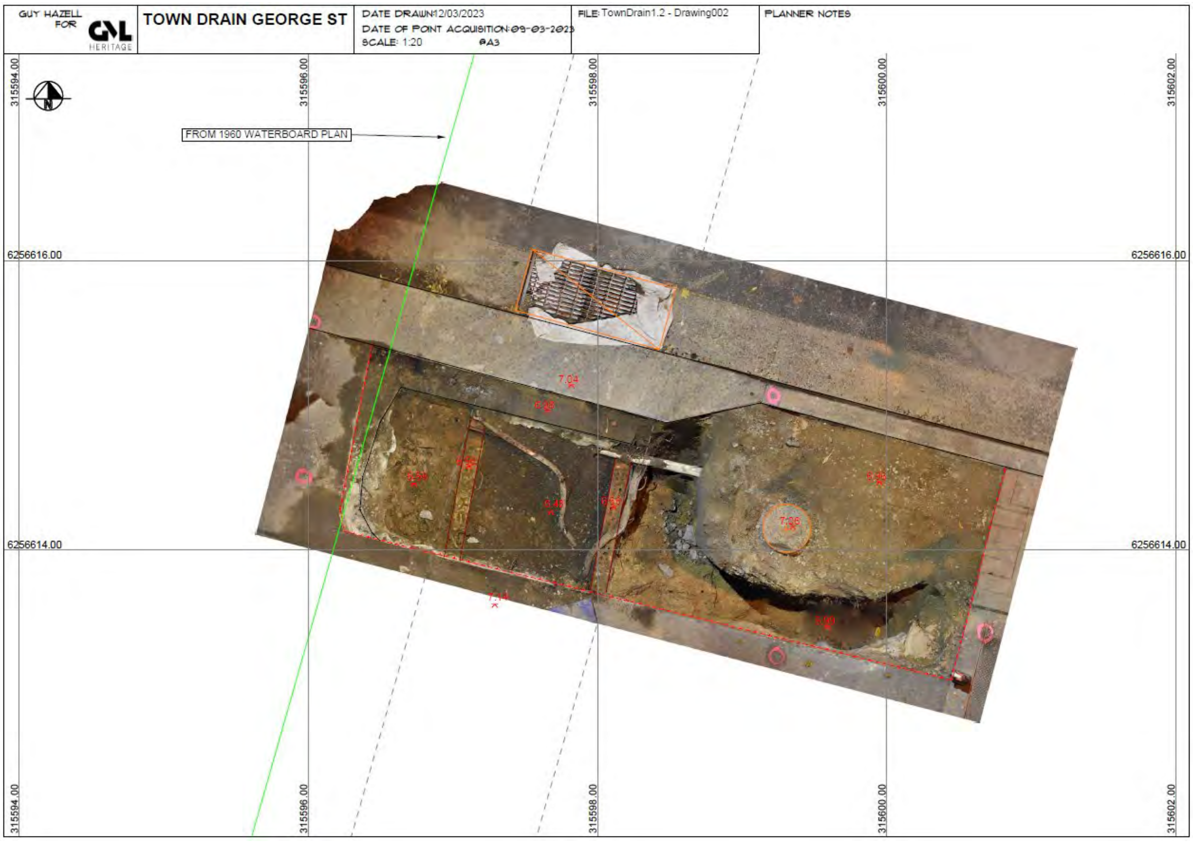


Figure 11 Orthophotograph showing the NDD investigation trench and the 20th century brick modification to the top of the Town Drain in relation to the projected alignment (green line). (Source: Arcsurv 2023)

Discussion

The results of the investigation clarify the position of the Town Drain in an area which had previously been poorly understood. The Town Drain is close to the projected alignment, and the portion underneath George Street is confirmed to be of brick barrel construction.

Conclusions

- A brick feature within the NDD test trench was interpreted as a twentieth century modification to the top of the Town Drain. The feature was located at a depth of c400mm (RL 6.7m) below the modern ground surface in the southern footpath in front of 85 George Street.
- Visual inspection through a modern stormwater grate immediately north of the NDD trench indicates that a section of the original brick barrel Town Drain survives intact beneath George Street. This section of the town drain is located outside the proposed route for the discharge line.

- No evidence of the original fabric of the Town Drain was observed within the NDD trench. The original fabric of the Town Drain and associated archaeology may survive at depth below the twentieth century brick modification.
- The conduit for the discharge line was installed above the twentieth century brick modification and the works did not have an impact on the Town Drain.

Recommendations

- No further excavation above or around the Parramatta Town Drain should be undertaken.
- The results of the NDD investigation should be included in the Archaeological Impact Assessment being prepared for the proposed Parramatta station site water treatment plant discharge line.

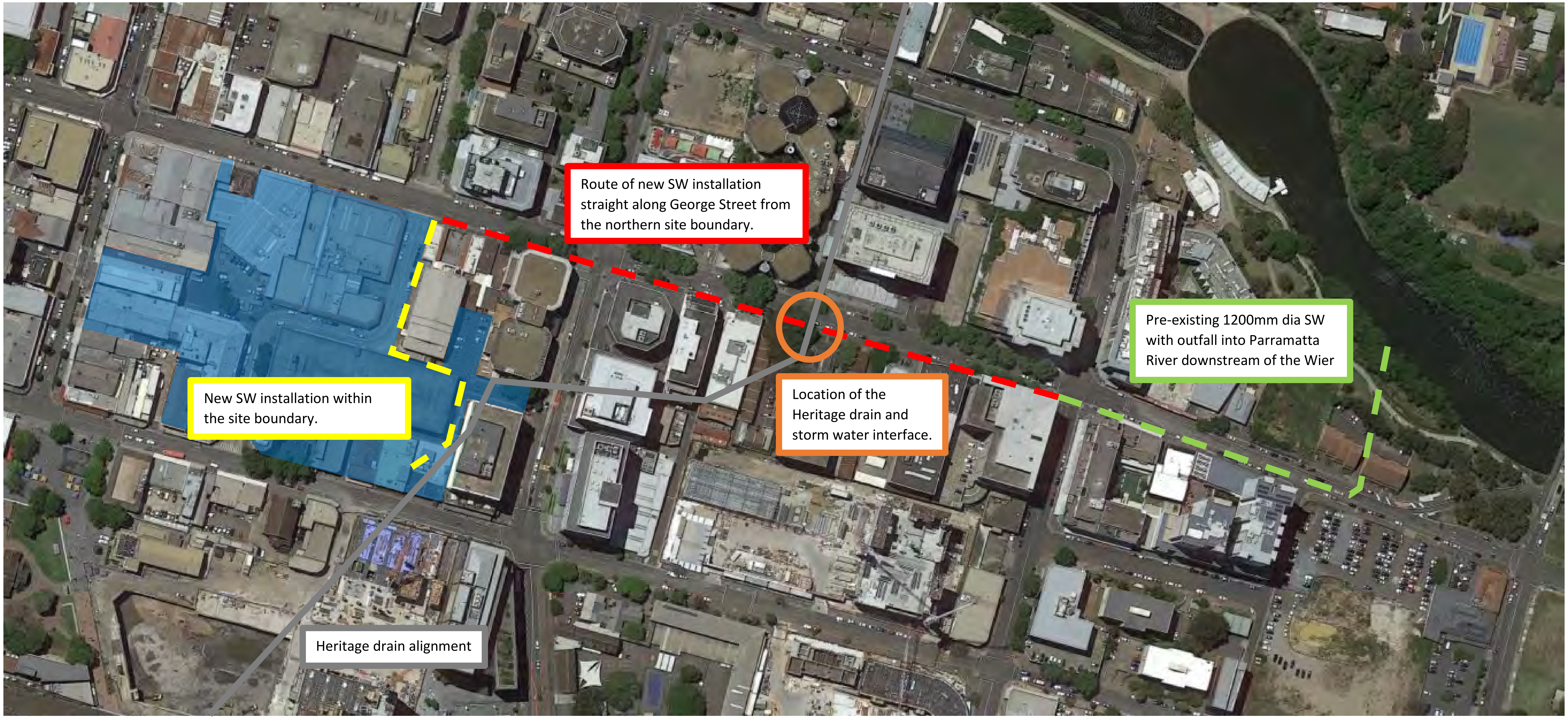
Endnotes

[1] Both open and capped sections of the Town Drain were recorded during the archaeological excavations at PS3 by Casey & Lowe. Refer to the excavation report 2020.

Appendix B

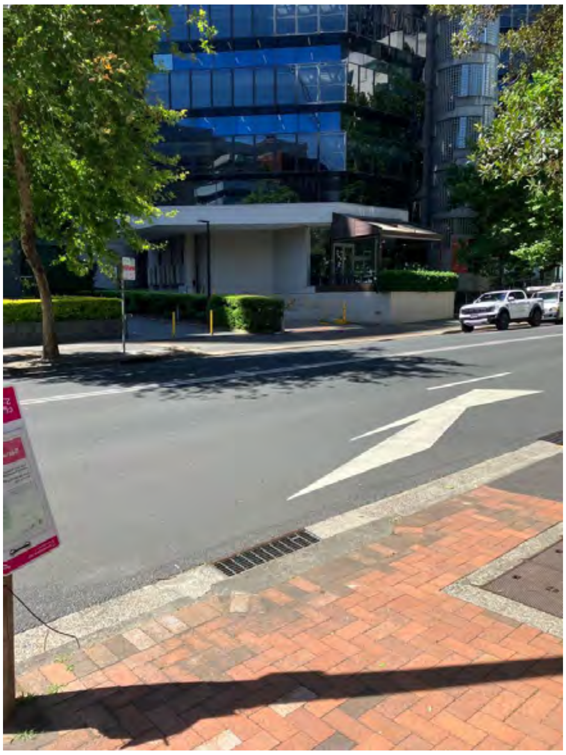
Plan of proposed route

Proposed New Storm Water Alignment



Methodology for the Heritage Interface Between the Storm Water Line and the Convict Drain

1. The work will take place out of hours due to the interface with George Street and the pedestrian walkway. With the work taking place out of hours we will require noise monitoring and additional environmental controls as advised by the GLC environmental team.
2. A traffic management plan will need to be in place and approved by parramatta council ahead of time.
3. The plan is to expose the convict drain within the George street footpath, so the first step of the excavation will be to remove the block paving for the section of drain we are looking to expose. This may require saw cutting depending on the subgrade of the block paving which would need to be carried out prior to 10pm as per OOHW approvals. In previous instances we have been able to lift this paving by hand.



4. Once the block paving has been removed, we would excavate a trench parallel to George Street until we are able to expose the top of the convict drain. We suspect the drain is at around 600mm in depth.
   Hold Point - Excavation must only happen in this instance using NDD methods, we propose a combination of dry vac and hand excavation. No other method of excavation is permitted until the drain has been positively identified, and even then mechanical excavation must not be used within 1m of the drain.
5. When we achieve up to 1m depth without finding the drain, then we will stop the excavation and move the trench along George Street. We would not proceed past 1m depth because we are unlikely to need the storm water drain to have more than 600mm cover.
6. We will continue this method until we can expose the full extent of the drain as per the below from previous investigation works on the convict drain.

7. With the full extent of the drain exposed we would firstly survey and record the location of the drain.

8. A separation layer would then be required over the top of the drain, we propose using a 0.2mm polyethene sheet to achieve this as that will be enough to ensure there is no bonding between the pipe surround and the drain covers.
9. We would then propose laying a length of 200mm diameter conduit over the drain so that it extends a minimum of 1m over either side of the drain.
10. The conduit would then be surveyed and backfilled with sand and the foot path reinstated.
11. This would then remove the need to excavate over the top of the convict drain for a second time to install the piping. We anticipate the diameter of the pressurised storm water run will be below 200mm and so we should be able to feed the storm water pipe through the conduit installed during the investigation.

This method purely covers the investigation works for the convict drain in the highlighted George Street location.

Appendix B – Construction Noise and Vibration Impact Assessment

Construction noise and vibration impact statement

George St Water Discharge Route

Project	SMW WTP - Westmead and Parramatta		
Client	Gamuda Laing O'Rourke Consortium		
Assessment Date	02/03/2023	Assessment Id	PARRA-036
Proposed start date	5/06/2023	Proposed end date	9/06/2023

Contents

Acoustic terms and acronyms

AA	Acoustic Advisor
AMM	Additional mitigation measures – applicable where standard measures have been implemented and NML is still expected to be exceeded.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
ICNG	Interim Construction Noise Guideline (Department of Environment and Climate Change 2009)
NCA	Noise Catchment Area
Noise level statistics	L_{A90} - The A-weighted sound pressure level exceeded 90% of the monitoring period. This is considered to represent the background noise. L_{Aeq} - The equivalent continuous A-weighted noise level—the level of noise equivalent to the energy average of noise levels occurring over a measurement period. L_{A1} – The A-weighted sound pressure level exceeded 1% of the monitoring period. L_{Amax} – The maximum A-weighted noise level associated with the measurement period.
NML	Noise Management Level
PPV	Peak Particle Velocity – Measurement of ground-borne vibration in units of mm/s
RBL	Rating Background Level - a single figure that represents the background noise level for assessment purposes
ROL	Road Occupancy Licence – granted by Transport for NSW and required for any activity likely to impact on traffic flow.
SWL	Sound Power Level - The A-weighted sound power level is a logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
SPL	Sound pressure level - This is the level of noise, usually expressed in dB(A), as measured by a standard sound level meter with a pressure microphone. The sound pressure level in dB(A) gives a close indication of the subjective loudness of noise. A technical definition for the sound pressure level, in decibels, is 20 times the logarithm (base 10) of the ratio of any two quantities related to a given sound pressure to a reference pressure (typically 20 µPa equivalent to 0 dB).
Tonal noise	Noise with perceptible and definite pitch or tone
VDV	Vibration dose value – used when assessing intermittent vibration as it is sensitive to peaks in vibration acceleration and accumulates the vibration energy received over the daytime and night-time periods

1 Introduction

1.1 Overview

The Sydney Metro Western Tunnelling Package is being delivered by the Gamuda Australia and Laing O'Rourke Consortium (GLC) and includes twin nine-kilometre tunnels between Sydney Olympic Park and Westmead, excavation of two new metro stations, and a stabling and maintenance facility at Clyde (the Project).

During the Project, there is potential for nearby sensitive receivers to experience adverse impacts relating to noise and vibration. The project's Noise and Vibration Management Sub Plan (NVMP) was developed to satisfy the project's Conditions of Approval (CoA) and addresses the assessment and management of noise and vibration impacts during construction.

Under the NVMP, KNOWnoise™, a project-specific noise prediction tool, has been developed to prepare a Construction noise and vibration impact statement (CNIS) for site and activity-specific noise works and provide ongoing risk analysis during project delivery and for when out-of-hours work is proposed (as per the Project's out-of-hours protocol).

This CNIS has been prepared using KNOWnoise™ and addresses activities for construction of the Westmead and Parramatta station boxes and utilities corridor between the two sites, as illustrated in Figure 1.

The structure of this CNIS includes:

- Section 1.2 – Construction works and hours with justification for these works in Section 1.3
- Section 2 – Existing environment
- Section 3 – Assessment framework including noise and vibration management levels
- Section 4 – Construction noise assessment
- Section 5 – Mitigation and management, including consultation

1.2 Planned works

GLC plans to carry out the works described in Appendix A, which lists each assessed activity, its timing and proposed equipment.

1.3 Justification of the works

In line with the Interim Construction Noise Guidelines (DECC 2009), justification is typically required to work outside approved construction hours. These situations may involve low impact or emergency works and works under an out-of-hours work protocol.

GLC proposes the works subject to this assessment outside approved construction hours for the following reason.

- Works are required to be completed outside of standard construction hours as (a) the applicable council permits and Road Occupancy License (ROL) for access to the footpaths and road network will only be issued for non-peak periods (i.e. weekend, evening and night works) along Smith Street; and (b) works are required to be completed without obstructing access to the public and adjacent commercial premises).

Figure 1 Location map

1 Existing environment

1.1 Sensitive receivers

The Westmead study area is centred on the Westmead metro station construction site. The construction site is located to the south of the existing Westmead Station and is bound by Hawkesbury Road to the west, Hassall Street to the east and Baily Street to the south.

Existing noise levels in this study area are generally controlled by transportation noise from the surrounding road network and existing rail line. The area surrounding the construction site is generally suburban and the nearest receivers are residential.

The Parramatta study area is centred on the Parramatta metro station construction site. The construction site is located between George Street and Macquarie Street, and between Church Street and Smith Street.

Existing noise levels in this study area are controlled by road traffic noise and general urban hum associated with the CBD. As with any CBD, existing noise levels and are relatively high during the daytime, evening and night-time. The area surrounding the construction site is mainly commercial and the nearest receivers are close to the boundary of the site. The nearest receivers are typically of general office or retail use.

1.2 Noise catchment areas

To facilitate the assessment of noise impacts from the project and to apply representative Noise Management Levels (NMLs) to all receivers, receivers adjacent to the Westmead and Parramatta sites have been divided into Noise Catchment Areas (NCAs). The Westmead site contains two noise catchments (NCA01 and NCA02) and NCA03 comprises the Parramatta CBD.

NCAs group individual sensitive receivers by representative traits such as existing noise environment and potential exposure to noise and vibration from the Project.

NCAs established as part of the EIS are summarised in Table 1 and illustrated in Figure 1. Background noise monitoring has been completed as part of the EIS to apply appropriate NML to each NCA.

Table 1 Summary of work areas, Noise Catchment Areas and land uses

NCA	Location	Description
1	Westmead	North of the existing rail corridor in Westmead and mainly residential. ‘Other sensitive’ receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.
2		South of the existing rail corridor and mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.
3	Parramatta	Covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many ‘other sensitive’ receivers in this catchment, including Western Sydney University, Arthur Phillip High School, Parramatta Public School, and a number of hotels and places of worship.

2 Assessment framework

2.1 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2. Use of power saws, rock breakers, drills and other tonal or impulsive activities are defined as annoying under the Interim Construction Noise Guideline (ICNG) and are 'highly noise intensive works'.

Table 2 Approved construction hours

CoA	Construction activity	Monday to Friday	Saturday	Sunday / Public holiday
D35	Approved construction	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work (unless approved under EPL or out-of-hours work protocol)
D36	Highly noise intensive works	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work (unless approved under EPL or out-of-hours work protocol)

Notes:

1. if continuously, then not exceeding three hours, with a minimum cessation of work of not less than one hour.

2.2 Noise assessment criteria

2.2.1 Construction noise

The ICNG describes noise in excess of the background level as potentially having an adverse impact on sensitive receivers and increasing the likelihood of complaint. During standard construction hours, where construction noise is within 10 dB(A) of the RBL, impacts would be acceptable.

Where construction noise is more than 10 dB(A) above the RBL during standard construction hours, a residential receiver is considered noise affected and the proponent should undertake all reasonable and feasible steps necessary to manage the impact and consult with the affected community.

Above a $L_{Aeq,\ 15\ minute}$ noise level of 75 dB(A), a receiver is highly affected, requiring consideration of additional mitigation measures including alternative accommodation in the night period.

Outside standard construction hours, construction noise at a residential receiver more than 5 dB(A) above the RBL is taken to be noise affected. Table 1 (reproduced from Table 2 of the ICNG) sets out the NMLs for residences and how they are to be applied.

In addition, annoying noise such as rock hammers, impact piling, or other impulsive noise sources usually result in greater annoyance than continuous construction noise. A 5 dB(A) penalty is applicable to such activities prior to comparison with the NMLs.

2.2.2 Sleep disturbance

The CNVS requires maximum noise levels to be analysed in terms of the extent and number of times the maximum noise exceeds specific noise trigger levels, in general accordance with the Noise Policy for Industry (NPfI) (EPA 2017). These triggers are:

- LAeq, 15 minute 40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and the
- LAmax 52 dBA or the prevailing RBL plus 15 dB, whichever is greater.

The NPfI also recommends the DECCW (2011) Road Noise Policy (RNP) be reviewed for further risk assessment. The RNP recommends maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep and one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

Table 3 Residential noise management levels

Time of day	NML $L_{Aeq\ (15\ min)}$ *	How to apply
Standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Other sensitive land uses, such as schools and offices, typically find noise from construction disruptive when the properties are being used (such as during work and school times). The noise management levels for non-residential receivers set in accordance with the Interim Construction Noise Guideline are provided in Table 4. These levels apply only during hours when the non-residential premises are being used.

The difference between an internal noise level and the external noise level is about 10 dB(A), which provides a conservative assumption that windows are open for ventilation. Buildings where windows are fixed or cannot otherwise be opened may achieve a greater noise level performance.

Table 4 Non-residential sensitive land uses noise management levels

Land use	Noise assessment location	NML ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Places of worship		
Active recreation areas (such as sporting activities and activities which generate their own noise or focus for participants)	External	65
Passive recreation areas (contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External	60
Industrial premises	External	75
Office, retail outlets	External	70

2.3 Project construction noise management levels

The Project specific construction noise management levels for residential receivers have been established in line with the ICNG, based on the RBLs relevant to each NCA. These are presented in Table 5. NMLs for non-residential sensitive receivers are described in Table 4.

Table 5 Project specific construction NMLs

NCA	Noise Management Level, $L_{Aeq\ 15\ minute}$						
	Approved hours		Outside approved hours				
	Noise affected	Highly noise affected	Day	Evening	Night	Sleep disturbance (CNVS)	
						$L_{Aeq,\ 15\ minute}$	L_{Amax}
1	58	75	53	51	46	46	56
2	59	75	54	52	42	42	52
3	68	75	63	58	48	48	58

As part of planning for out of hours works, standard mitigation measures, as described in the CNVMP, are implemented where reasonable and feasible. However, after these measures have been applied, noise and vibration levels may continue to exceed the NMLs.

In this case, additional mitigation measures outlined in the CNVS, which largely focus on engagement with affected sensitive receivers, should be implemented where reasonable and feasible, unless other agreements are in place with the impacted receiver.

Triggers and additional mitigation measures for airborne noise are taken from the Project's OOHW Protocol and summarised in Table 6. Further details of specific additional mitigation measures are described in the CNVS.

Table 6 Triggers for additional mitigation measures – Airborne noise (Sydney Metro 2020)

Construction hours	Class	dB above NML	Additional management measures
Approved hours Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	N	0 to 10	-
	CA	10 to 20	LB
	MI	20 to 30	LB, M, SN
	HI	>30	LB, M, SN
Evening Monday – Friday: 6pm – 10pm Saturday: 7am – 8am, 6pm – 10pm Sunday / PH: 8am – 6pm	N	0 to 10	LB
	CA	10 to 20	LB, M
	MI	20 to 30	LB, M, SN, RO
	HI	> 30	LB, M, SN, IB, PC, RO
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am) Sunday / PH: 6pm –7am	N	0 to 10	LB
	CA	10 to 20	LB, M, SN, RO
	MI	20 to 30	LB, M, SN, IB, PC, RO, AA
	HI	> 30	LB, M, SN, IB, PC, RO, AA

Notes: PC = Phone Calls and emails
M = Monitoring
IB = Individual briefings
AA = Alternative accommodation
SN = Specific notification
LB = Letterbox drops
RO = Project specific respite offer

N = Noticeable CA = Clearly audible MI Moderately intrusive HI = Highly intrusive

2.4 Vibration management

2.4.1 Human comfort

When assessing human exposure to construction-related vibration, the CNVS requires vibration goals to be established using *Environmental Noise Management Assessing Vibration: A Technical Guideline* (DECC 2006), which provides criteria for the assessment of vibration impacts on humans.

Construction activities typically generate vibration of an intermittent nature, which is assessed using a Vibration Dose Value (VDV). Acceptable values of vibration doses are presented in Table 7 for sensitive receivers.

Table 7 VDV Vibration criteria

Receiver type	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings – 16 hour day (7am to 11pm)[1]	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings – 8 hour night (11pm to 7am)[1]	0.13	0.26	0.51

Note 1: Day time and night time as described in BS6472:1992 (as referenced in the CNVS), i.e. a daytime period of 16 h or a night time period of 8 h, for example 23.00 h to 07.00 h.

2.4.2 Buildings

Potential building damage from construction vibration requires the application of values in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings* Part 2. These values are presented in Table 8 and relate to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Table 8 Guideline values for vibration velocity for the effects of short-term vibration on structures (BS 7385).

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz to 50 mm/s at 40 Hz and above

Where vibration may give rise to magnification due to resonance, especially at lower frequencies where lower guide values apply, the guide values may be reduced by 50%. The CNVS describes rock breaking/hammering and sheet piling activities as having potential to cause dynamic loading in some structures (e.g. residences).

For activity involving rock breakers, piling rigs, vibratory rollers, excavators, vibration predominantly occurs at frequencies in the 10 Hz to 100 Hz range. On this basis, a conservative vibration damage screening level is:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

2.4.3 Heritage

Heritage buildings and structures would be assessed under a conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150). Where vibration levels at heritage items are identified as exceeding this screening level, structural assessment would be completed by the Project team to confirm the structure's sensitivity to vibration. If a heritage building or structure is found to be structurally unsound (following inspection) the conservative criterion would stand. Where the structure is suitably sound, the guideline values from Table 8 would be applicable.

2.4.4 Additional mitigation measures

The CNVS recommends additional mitigation measures where all standard mitigation measures to minimise vibration at the nearest receivers have been implemented and vibration is still predicted to exceed the maximum guideline values. The Additional Mitigation Measures Matrix (AMMM) for vibration from the CNVS is presented in Table 9.

Table 9 Additional Vibration Mitigation Measures (CNVS)

Construction hours	Mitigation measures where predicted vibration levels exceed maximum levels
Approved hours Monday – Friday: 7am – 6pm, Saturday: 8am to 6pm	LB, M, RO
Evening Monday – Friday: 6pm – 10pm; Saturday: 7am – 8am, 6pm – 10pm; Sunday / PH: 8am – 6pm	LB, M, IB, PC, RO, SN
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am); Sunday / PH: 6pm –7am	LB, M, IB, PC, RO, SN, AA

3 Impact assessment

3.1 Modelling method

Predictions of noise impacts were performed using KNOWnoise™, a project-specific noise assessment tool developed by Hutchison Weller for the CTP Project. KNOWnoise calculates the maximum $L_{Aeq,15minute}$ noise level for each identified receiver for each proposed activity using predictions from SoundPlan noise modelling software. Predictions include geometric spreading, air and ground absorptions as well as topographical and structural screening and reflection.

The following components were incorporated in the model:

- Topography – Based on terrain data of 1 m resolution.
- Individual sensitive receivers – Worst-affected façade of each building to 700 metres from the works
- Construction noise sources –Activities and equipment provided by GLC were included in the noise model as individual sources across the nominated work areas for each activity. The maximum predicted LAeq noise level within each work area was identified for each receiver.
- Cumulative impacts – all activities with overlapping time periods are included in cumulative results
- Source height – construction noise sources assumed to be at 1.5 metres above ground level.
- Ground Absorption – Ground assumed to be mixed hard and soft with absorption factor of 0.5
- Meteorology –worst-case meteorological conditions (gentle breeze from source to receiver and stable conditions).
- Residential building structures are included in the model, meaning screening provided by neighboring houses is considered.
- Results are shown for all floors of assessed buildings with the worst-case façade result assumed for the whole floor.

Equipment proposed to be used for OOHW activities together with estimated sound power levels for each item are summarised in Appendix A.

The sound power levels and ultimate predicted noise levels will depend on the number of plant items operating at any one time and their precise location relative to a sensitive receiver. In practice, the predicted levels will vary due to plant moving around the site and not operating intensively or concurrently for a 15 minute assessment period. Shielding and reflection provided by buildings will also vary as plant moves around the site. Therefore, predicted noise levels are conservative.

3.2 Predicted noise levels

Predicted impact classes for the Evening period are illustrated graphically in Appendix B. Each identified receiver in the study area has been coloured to highlight the predicted level of impact.

Detailed predicted noise levels for each potentially affected receiver are presented Appendix C.

Table 10 presents the worst-case predicted noise level of 87 dB(A) during the works, resulting in 25 receivers classed as highly noise affected.

Table 10 Summary of maximum predicted noise level and highly affected receivers for the Evening period.

Maximum cumulative predicted $L_{Aeq,\ 15\ minute}$ noise level	87 dB(A)
Number of highly noise affected receivers (>75 dB)	25

With reference to the CNVS, the number of senstive receivers classified in each impact class for each assessment period are summarised in the following tables.

Table 11 Summary of NML exceedance ranges for standard hours.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	56
Clearly Audible	10 <= 20 dB above NML	12
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 12 Summary of NML exceedance ranges for outside standard hours - weekend.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	56
Clearly Audible	10 <= 20 dB above NML	12
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 13 Summary of NML exceedance ranges for outside standard hours - evenings.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	56
Clearly Audible	10 <= 20 dB above NML	12

Impact class	Predicted noise level	Predicted number of receivers
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 14 Summary of NML exceedance ranges for outside standard hours - nights.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	170
Clearly Audible	10 <= 20 dB above NML	12
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

In the event works are planned for more than two consecutive nights, sleep disturbance has been considered. Table 15 summarises the number of residents predicted to exceed the sleep disturbance screening criterion. Further analysis is also provided to indicate the number of receivers expected to be woken, at LAmax noise levels greater than 65 dBA.

Where exceedances of the awakening criteria are predicted, additional care should be taken, and mitigation measures implemented in line with the CNVS.

Table 15 Summary of predicted exceedances of sleep disturbance screening criterion and awakening criterion.

Criterion	Predicted number of receivers
Potentially Sleep Disturbed (exceed RBL + 15 screening criterion)	0
Exceed 65 dBA awakening criterion	0

3.3 Vibration

The CNVS requires attended vibration measurements at commencement of vibration generating activities to confirm vibration levels satisfy the criteria for that activity.

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. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

Based on the proposed work locations and selected equipment, indicative exceedances of the vibration criteria are summarised in Table 16. The exceedances are based on recommended minimum working distances from vibration intensive plant given in Appendix D of the Construction Noise and Vibration Strategy (Transport for NSW 2019). Vibration impacts for each sensitive receiver are listed in Appendix C.

Table 16 Predicted exceedances of vibration criteria

Impact classification	Number of potentially affected receivers
Human comfort	0
Cosmetic damage	0
Heritage structure	0

4 Controls and safeguards

The Project represents a risk of adverse impacts on sensitive receivers, particularly when working close to the project boundary and outside approved hours.

Where short term noise impacts are unavoidable, mitigation measures described in the project construction environment management plan should be implemented together with the recommendations in in Table 14.

Table 17 and additional mitigation measures for each receiver identified in Appendix B and summarised in Table 14.

Table 17 Standard mitigation measures

Community consultation	• Potentially affected receivers will be notified of OOH works in accordance with project requirements. • Where practicable, works will be scheduled to not conflict with major student examination periods, church congregation times, and other sensitive periods identified through community consultation.
Site induction	• All workers will be inducted to the project prior to commencing work and will be cognisant of their noise and vibration obligations under the CNVMP.
Behavioural practices	• Avoid swearing and unnecessary shouting or loud radios onsite. • Avoid dropping materials from height.
Equipment selection	• Priority given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable. • The noise levels of plant and equipment would meet the maximum noise requirements of the CNVS.
Use and siting of plant	• Locate compounds away from sensitive receivers and discourage access from local roads. • Plant used intermittently to be throttled down or shut down. • Noise-emitting plant to be directed away from sensitive receivers where possible. • Stationary plant should be located behind a structure or enclosed if practicable. • Deliveries should be made as far as practical from sensitive receivers. Dedicated loading/unloading sites should be shielded where possible, if close to receivers. • Plan traffic flow, parking and loading/unloading areas to minimise reversing. • Avoid compression breaking on approach to the site. • Where additional activities or plant may result in marginal noise increases and speed works up, consider concentrating activities at one location and complete works as quickly as possible.
Non-tonal reversing alarms.	• Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Noise monitoring	• Monitoring should be completed to verify the assumptions of this CNVIS regarding estimated equipment noise emissions and to ensure compliance with the CNVS.
Vibration monitoring	• Attended vibration measurements should be completed at commencement of vibration generating activities predicted to occur within safe working distances for cosmetic damage. • Where monitoring demonstrates maximum levels exceeded, consider alternative methodologies/equipment
Implement any project specific mitigation measures	
1	Mitigation mesasures as per Project NVMP & DNVIS.

Table 18 Additional mitigation measures

Code	Measure	Description
AA	Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.
M	Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, 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 receiver have 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 has been exceeded so that additional management measures may be implemented.
IB	Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
LB	Letterbox drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.
RO	Respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.
PC	Phone calls	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Appendix A Proposed activities and associated sound power levels

Section 1 - Stage 1 - Saw Cutting Pavement

Pipeline located below ground. Saw cutting will be required for the removal of the footpath and roadway pavement.
5/06/2023 8:00:47 PM - 9/06/2023 10:00:17 PM

Equipment	Quantity	Usage	Reduction	SWL
Concrete Saw (Std)*	1	30 %	3	111
Daymakers / Lighting plant	1	100 %	0	93
Light vehicle	1	10 %	0	75

Activity Sound Power Level: 111
* includes 5 dB penalty for potentially annoying characteristics in line with the ICNG

Appendix B Map showing predicted noise impacts by impact class

Appendix C Detailed predictions

C.1 Noise

GAMUDA Australia | LAING O'ROURKE

Construction noise impact statement

Assessment: George St Water Discharge Route					NML, LAeq, 15 minute				Sleep, LAmax		Predicted noise level, dBA		Exceedance summary										
														Exceed NML by (dB):				Exceed sleep disturbance by (dB):		Impact classification			
NCA	Rec	Address	Flr	Land use	Day	O/day	Eve	Night	Screen	Awake	Cumulative LAeq, 15 minute	LMax	Highly Affected?	Day	O/day	Eve	Night	Screen	Awake	Day	O/day	Eve	Night
NCA03	745603	"52 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745602	"52 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745117	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	2	COM	70	70	70	70			86	91	Y	16	16	16	16	-	16	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745116	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	1	COM	70	70	70	70			87	92	Y	17	17	17	17	-	17	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745115	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	9	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745114	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	8	COM	70	70	70	70			76	82	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745113	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	7	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745112	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	6	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	745111	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	5	COM	70	70	70	70			80	85	Y	10	10	10	10	-	10	Noticable	Noticable	Noticable	Noticable
NCA03	745110	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	4	COM	70	70	70	70			82	87	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745109	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	3	COM	70	70	70	70			83	89	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745065	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	10	COM	70	70	70	70			70	75		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745064	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	9	COM	70	70	70	70			70	76		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745063	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	8	COM	70	70	70	70			70	76		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745062	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	7	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745061	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	6	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745060	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	5	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745059	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	4	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744973	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	3	COM	70	70	70	70			71	77		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744972	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	2	COM	70	70	70	70			70	75		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744970	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	11	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744969	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	10	COM	70	70	70	70			71	77		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744968	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	9	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744967	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	8	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744966	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	7	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744965	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	6	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744964	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	5	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744963	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	4	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744761	"119 MACQUARIE ST, PARRAMATTA"	2	PoW	55	55	55	55			56	61		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744760	"119 MACQUARIE ST, PARRAMATTA"	1	PoW	55	55	55	55			55	60		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744691	"48 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744690	"48 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			70	75		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744689	"48 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable

NCA03	744688	"48 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744687	"48 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744686	"48 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744680	"244 CHURCH ST, PARRAMATTA"	1	EDU	55	55	55	55			61	66		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	744541	"94 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			82	88	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744540	"94 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			83	88	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744539	"94 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			83	88	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744530	"SE 1 LEVEL 7 1 HORWOOD PL, PARRAMATTA"	10	COM	65	65	65	65			66	71		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744529	"SE 1 LEVEL 7 1 HORWOOD PL, PARRAMATTA"	9	COM	65	65	65	65			66	71		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744528	"SE 1 LEVEL 7 1 HORWOOD PL, PARRAMATTA"	8	COM	65	65	65	65			65	71		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744527	"SE 1 LEVEL 7 1 HORWOOD PL, PARRAMATTA"	7	COM	65	65	65	65			65	70		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744506	"2 HORWOOD PL, PARRAMATTA"	4	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744505	"2 HORWOOD PL, PARRAMATTA"	3	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744504	"2 HORWOOD PL, PARRAMATTA"	2	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744503	"2 HORWOOD PL, PARRAMATTA"	1	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744210	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	13	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744209	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744208	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			74	80		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744207	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			75	80	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	744206	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	744205	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	744204	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	744203	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			79	84	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	744202	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			80	85	Y	10	10	10	10	-	10	Noticable	Noticable	Noticable	Noticable
NCA03	744201	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			82	87	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744200	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			83	89	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744199	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			85	90	Y	15	15	15	15	-	15	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744198	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			87	92	Y	17	17	17	17	-	17	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744197	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	14	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744104	"THE ROXY ARCADE 73 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			87	92	Y	17	17	17	17	-	17	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744065	"LEVEL 3 3 HORWOOD PL, PARRAMATTA"	8	COM	70	70	70	70			70	75		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744064	"LEVEL 3 3 HORWOOD PL, PARRAMATTA"	7	COM	70	70	70	70			70	75		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744063	"LEVEL 3 3 HORWOOD PL, PARRAMATTA"	6	COM	70	70	70	70			70	76		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744062	"LEVEL 3 3 HORWOOD PL, PARRAMATTA"	5	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744061	"LEVEL 3 3 HORWOOD PL, PARRAMATTA"	4	COM	70	70	70	70			70	76		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable

C.2 Vibration

NCA	Receiver	Address	Land use	Vibration Impact

Construction noise and vibration impact statement

George St Water Discharge Route

Project	SMW WTP - Westmead and Parramatta		
Client	Gamuda Laing O'Rourke Consortium		
Assessment Date	02/03/2023	Assessment Id	PARRA-036
Proposed start date	5/06/2023	Proposed end date	10/06/2023

Contents

Acoustic terms and acronyms

AA	Acoustic Advisor
AMM	Additional mitigation measures – applicable where standard measures have been implemented and NML is still expected to be exceeded.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
ICNG	Interim Construction Noise Guideline (Department of Environment and Climate Change 2009)
NCA	Noise Catchment Area
Noise level statistics	L_{A90} - The A-weighted sound pressure level exceeded 90% of the monitoring period. This is considered to represent the background noise. L_{Aeq} - The equivalent continuous A-weighted noise level—the level of noise equivalent to the energy average of noise levels occurring over a measurement period. L_{A1} – The A-weighted sound pressure level exceeded 1% of the monitoring period. L_{Amax} – The maximum A-weighted noise level associated with the measurement period.
NML	Noise Management Level
PPV	Peak Particle Velocity – Measurement of ground-borne vibration in units of mm/s
RBL	Rating Background Level - a single figure that represents the background noise level for assessment purposes
ROL	Road Occupancy Licence – granted by Transport for NSW and required for any activity likely to impact on traffic flow.
SWL	Sound Power Level - The A-weighted sound power level is a logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
SPL	Sound pressure level - This is the level of noise, usually expressed in dB(A), as measured by a standard sound level meter with a pressure microphone. The sound pressure level in dB(A) gives a close indication of the subjective loudness of noise. A technical definition for the sound pressure level, in decibels, is 20 times the logarithm (base 10) of the ratio of any two quantities related to a given sound pressure to a reference pressure (typically 20 µPa equivalent to 0 dB).
Tonal noise	Noise with perceptible and definite pitch or tone
VDV	Vibration dose value – used when assessing intermittent vibration as it is sensitive to peaks in vibration acceleration and accumulates the vibration energy received over the daytime and night-time periods

1 Introduction

1.1 Overview

The Sydney Metro Western Tunnelling Package is being delivered by the Gamuda Australia and Laing O'Rourke Consortium (GLC) and includes twin nine-kilometre tunnels between Sydney Olympic Park and Westmead, excavation of two new metro stations, and a stabling and maintenance facility at Clyde (the Project).

During the Project, there is potential for nearby sensitive receivers to experience adverse impacts relating to noise and vibration. The project's Noise and Vibration Management Sub Plan (NVMP) was developed to satisfy the project's Conditions of Approval (CoA) and addresses the assessment and management of noise and vibration impacts during construction.

Under the NVMP, KNOWnoise™, a project-specific noise prediction tool, has been developed to prepare a Construction noise and vibration impact statement (CNIS) for site and activity-specific noise works and provide ongoing risk analysis during project delivery and for when out-of-hours work is proposed (as per the Project's out-of-hours protocol).

This CNIS has been prepared using KNOWnoise™ and addresses activities for construction of the Westmead and Parramatta station boxes and utilities corridor between the two sites, as illustrated in Figure 1.

The structure of this CNIS includes:

- Section 1.2 – Construction works and hours with justification for these works in Section 1.3
- Section 2 – Existing environment
- Section 3 – Assessment framework including noise and vibration management levels
- Section 4 – Construction noise assessment
- Section 5 – Mitigation and management, including consultation

1.2 Planned works

GLC plans to carry out the works described in Appendix A, which lists each assessed activity, its timing and proposed equipment.

1.3 Justification of the works

In line with the Interim Construction Noise Guidelines (DECC 2009), justification is typically required to work outside approved construction hours. These situations may involve low impact or emergency works and works under an out-of-hours work protocol.

GLC proposes the works subject to this assessment outside approved construction hours for the following reason.

- Works are required to be completed outside of standard construction hours as (a) the applicable council permits and Road Occupancy License (ROL) for access to the footpaths and road network will only be issued for non-peak periods (i.e. weekend, evening and night works) along Smith Street; and (b) works are required to be completed without obstructing access to the public and adjacent commercial premises).

Figure 1 Location map

1 Existing environment

1.1 Sensitive receivers

The Westmead study area is centred on the Westmead metro station construction site. The construction site is located to the south of the existing Westmead Station and is bound by Hawkesbury Road to the west, Hassall Street to the east and Baily Street to the south.

Existing noise levels in this study area are generally controlled by transportation noise from the surrounding road network and existing rail line. The area surrounding the construction site is generally suburban and the nearest receivers are residential.

The Parramatta study area is centred on the Parramatta metro station construction site. The construction site is located between George Street and Macquarie Street, and between Church Street and Smith Street.

Existing noise levels in this study area are controlled by road traffic noise and general urban hum associated with the CBD. As with any CBD, existing noise levels and are relatively high during the daytime, evening and night-time. The area surrounding the construction site is mainly commercial and the nearest receivers are close to the boundary of the site. The nearest receivers are typically of general office or retail use.

1.2 Noise catchment areas

To facilitate the assessment of noise impacts from the project and to apply representative Noise Management Levels (NMLs) to all receivers, receivers adjacent to the Westmead and Parramatta sites have been divided into Noise Catchment Areas (NCAs). The Westmead site contains two noise catchments (NCA01 and NCA02) and NCA03 comprises the Parramatta CBD.

NCAs group individual sensitive receivers by representative traits such as existing noise environment and potential exposure to noise and vibration from the Project.

NCAs established as part of the EIS are summarised in Table 1 and illustrated in Figure 1. Background noise monitoring has been completed as part of the EIS to apply appropriate NML to each NCA.

Table 1 Summary of work areas, Noise Catchment Areas and land uses

NCA	Location	Description
1	Westmead	North of the existing rail corridor in Westmead and mainly residential. 'Other sensitive' receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.
2		South of the existing rail corridor and mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.
3	Parramatta	Covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many 'other sensitive' receivers in this catchment, including Western Sydney University, Arthur Phillip High School, Parramatta Public School, and a number of hotels and places of worship.

2 Assessment framework

2.1 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2. Use of power saws, rock breakers, drills and other tonal or impulsive activities are defined as annoying under the Interim Construction Noise Guideline (ICNG) and are 'highly noise intensive works'.

Table 2 Approved construction hours

CoA	Construction activity	Monday to Friday	Saturday	Sunday / Public holiday
D35	Approved construction	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work (unless approved under EPL or out-of-hours work protocol)
D36	Highly noise intensive works	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work (unless approved under EPL or out-of-hours work protocol)

Notes:

1. if continuously, then not exceeding three hours, with a minimum cessation of work of not less than one hour.

2.2 Noise assessment criteria

2.2.1 Construction noise

The ICNG describes noise in excess of the background level as potentially having an adverse impact on sensitive receivers and increasing the likelihood of complaint. During standard construction hours, where construction noise is within 10 dB(A) of the RBL, impacts would be acceptable.

Where construction noise is more than 10 dB(A) above the RBL during standard construction hours, a residential receiver is considered noise affected and the proponent should undertake all reasonable and feasible steps necessary to manage the impact and consult with the affected community.

Above a $L_{Aeq,\ 15\ minute}$ noise level of 75 dB(A), a receiver is highly affected, requiring consideration of additional mitigation measures including alternative accommodation in the night period.

Outside standard construction hours, construction noise at a residential receiver more than 5 dB(A) above the RBL is taken to be noise affected. Table 1 (reproduced from Table 2 of the ICNG) sets out the NMLs for residences and how they are to be applied.

In addition, annoying noise such as rock hammers, impact piling, or other impulsive noise sources usually result in greater annoyance than continuous construction noise. A 5 dB(A) penalty is applicable to such activities prior to comparison with the NMLs.

2.2.2 Sleep disturbance

The CNVS requires maximum noise levels to be analysed in terms of the extent and number of times the maximum noise exceeds specific noise trigger levels, in general accordance with the Noise Policy for Industry (NPfI) (EPA 2017). These triggers are:

- LAeq, 15 minute 40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and the
- LAmax 52 dBA or the prevailing RBL plus 15 dB, whichever is greater.

The NPfI also recommends the DECCW (2011) Road Noise Policy (RNP) be reviewed for further risk assessment. The RNP recommends maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep and one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

Table 3 Residential noise management levels

Time of day	NML $L_{Aeq\ (15\ min)}$ *	How to apply
Standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Other sensitive land uses, such as schools and offices, typically find noise from construction disruptive when the properties are being used (such as during work and school times). The noise management levels for non-residential receivers set in accordance with the Interim Construction Noise Guideline are provided in Table 4. These levels apply only during hours when the non-residential premises are being used.

The difference between an internal noise level and the external noise level is about 10 dB(A), which provides a conservative assumption that windows are open for ventilation. Buildings where windows are fixed or cannot otherwise be opened may achieve a greater noise level performance.

Table 4 Non-residential sensitive land uses noise management levels

Land use	Noise assessment location	NML ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Places of worship		
Active recreation areas (such as sporting activities and activities which generate their own noise or focus for participants)	External	65
Passive recreation areas (contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External	60
Industrial premises	External	75
Office, retail outlets	External	70

2.3 Project construction noise management levels

The Project specific construction noise management levels for residential receivers have been established in line with the ICNG, based on the RBLs relevant to each NCA. These are presented in Table 5. NMLs for non-residential sensitive receivers are described in Table 4.

Table 5 Project specific construction NMLs

NCA	Noise Management Level, $L_{Aeq\ 15\ minute}$						
	Approved hours		Outside approved hours				
	Noise affected	Highly noise affected	Day	Evening	Night	Sleep disturbance (CNVS)	
						$L_{Aeq,\ 15\ minute}$	L_{Amax}
1	58	75	53	51	46	46	56
2	59	75	54	52	42	42	52
3	68	75	63	58	48	48	58

As part of planning for out of hours works, standard mitigation measures, as described in the CNVMP, are implemented where reasonable and feasible. However, after these measures have been applied, noise and vibration levels may continue to exceed the NMLs.

In this case, additional mitigation measures outlined in the CNVS, which largely focus on engagement with affected sensitive receivers, should be implemented where reasonable and feasible, unless other agreements are in place with the impacted receiver.

Triggers and additional mitigation measures for airborne noise are taken from the Project's OOHW Protocol and summarised in Table 6. Further details of specific additional mitigation measures are described in the CNVS.

Table 6 Triggers for additional mitigation measures – Airborne noise (Sydney Metro 2020)

Construction hours	Class	dB above NML	Additional management measures
Approved hours Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	N	0 to 10	-
	CA	10 to 20	LB
	MI	20 to 30	LB, M, SN
	HI	>30	LB, M, SN
Evening Monday – Friday: 6pm – 10pm Saturday: 7am – 8am, 6pm – 10pm Sunday / PH: 8am – 6pm	N	0 to 10	LB
	CA	10 to 20	LB, M
	MI	20 to 30	LB, M, SN, RO
	HI	> 30	LB, M, SN, IB, PC, RO
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am) Sunday / PH: 6pm –7am	N	0 to 10	LB
	CA	10 to 20	LB, M, SN, RO
	MI	20 to 30	LB, M, SN, IB, PC, RO, AA
	HI	> 30	LB, M, SN, IB, PC, RO, AA

Notes: PC = Phone Calls and emails
M = Monitoring
IB = Individual briefings
AA = Alternative accommodation
SN = Specific notification
LB = Letterbox drops
RO = Project specific respite offer

N = Noticeable CA = Clearly audible MI Moderately intrusive HI = Highly intrusive

2.4 Vibration management

2.4.1 Human comfort

When assessing human exposure to construction-related vibration, the CNVS requires vibration goals to be established using *Environmental Noise Management Assessing Vibration: A Technical Guideline* (DECC 2006), which provides criteria for the assessment of vibration impacts on humans.

Construction activities typically generate vibration of an intermittent nature, which is assessed using a Vibration Dose Value (VDV). Acceptable values of vibration doses are presented in Table 7 for sensitive receivers.

Table 7 VDV Vibration criteria

Receiver type	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings – 16 hour day (7am to 11pm)[1]	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings – 8 hour night (11pm to 7am)[1]	0.13	0.26	0.51

Note 1: Day time and night time as described in BS6472:1992 (as referenced in the CNVS), i.e. a daytime period of 16 h or a night time period of 8 h, for example 23.00 h to 07.00 h.

2.4.2 Buildings

Potential building damage from construction vibration requires the application of values in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings* Part 2. These values are presented in Table 8 and relate to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Table 8 Guideline values for vibration velocity for the effects of short-term vibration on structures (BS 7385).

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz to 50 mm/s at 40 Hz and above

Where vibration may give rise to magnification due to resonance, especially at lower frequencies where lower guide values apply, the guide values may be reduced by 50%. The CNVS describes rock breaking/hammering and sheet piling activities as having potential to cause dynamic loading in some structures (e.g. residences).

For activity involving rock breakers, piling rigs, vibratory rollers, excavators, vibration predominantly occurs at frequencies in the 10 Hz to 100 Hz range. On this basis, a conservative vibration damage screening level is:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

2.4.3 Heritage

Heritage buildings and structures would be assessed under a conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150). Where vibration levels at heritage items are identified as exceeding this screening level, structural assessment would be completed by the Project team to confirm the structure's sensitivity to vibration. If a heritage building or structure is found to be structurally unsound (following inspection) the conservative criterion would stand. Where the structure is suitably sound, the guideline values from Table 8 would be applicable.

2.4.4 Additional mitigation measures

The CNVS recommends additional mitigation measures where all standard mitigation measures to minimise vibration at the nearest receivers have been implemented and vibration is still predicted to exceed the maximum guideline values. The Additional Mitigation Measures Matrix (AMMM) for vibration from the CNVS is presented in Table 9.

Table 9 Additional Vibration Mitigation Measures (CNVS)

Construction hours	Mitigation measures where predicted vibration levels exceed maximum levels
Approved hours Monday – Friday: 7am – 6pm, Saturday: 8am to 6pm	LB, M, RO
Evening Monday – Friday: 6pm – 10pm; Saturday: 7am – 8am, 6pm – 10pm; Sunday / PH: 8am – 6pm	LB, M, IB, PC, RO, SN
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am); Sunday / PH: 6pm –7am	LB, M, IB, PC, RO, SN, AA

3 Impact assessment

3.1 Modelling method

Predictions of noise impacts were performed using KNOWnoise™, a project-specific noise assessment tool developed by Hutchison Weller for the CTP Project. KNOWnoise calculates the maximum $L_{Aeq,15minute}$ noise level for each identified receiver for each proposed activity using predictions from SoundPlan noise modelling software. Predictions include geometric spreading, air and ground absorptions as well as topographical and structural screening and reflection.

The following components were incorporated in the model:

- Topography – Based on terrain data of 1 m resolution.
- Individual sensitive receivers – Worst-affected façade of each building to 700 metres from the works
- Construction noise sources –Activities and equipment provided by GLC were included in the noise model as individual sources across the nominated work areas for each activity. The maximum predicted LAeq noise level within each work area was identified for each receiver.
- Cumulative impacts – all activities with overlapping time periods are included in cumulative results
- Source height – construction noise sources assumed to be at 1.5 metres above ground level.
- Ground Absorption – Ground assumed to be mixed hard and soft with absorption factor of 0.5
- Meteorology –worst-case meteorological conditions (gentle breeze from source to receiver and stable conditions).
- Residential building structures are included in the model, meaning screening provided by neighboring houses is considered.
- Results are shown for all floors of assessed buildings with the worst-case façade result assumed for the whole floor.

Equipment proposed to be used for OOHW activities together with estimated sound power levels for each item are summarised in Appendix A.

The sound power levels and ultimate predicted noise levels will depend on the number of plant items operating at any one time and their precise location relative to a sensitive receiver. In practice, the predicted levels will vary due to plant moving around the site and not operating intensively or concurrently for a 15 minute assessment period. Shielding and reflection provided by buildings will also vary as plant moves around the site. Therefore, predicted noise levels are conservative.

3.2 Predicted noise levels

Predicted impact classes for the Evening period are illustrated graphically in Appendix B. Each identified receiver in the study area has been coloured to highlight the predicted level of impact.

Detailed predicted noise levels for each potentially affected receiver are presented Appendix C.

Table 10 presents the worst-case predicted noise level of 86 dB(A) during the works, resulting in 19 receivers classed as highly noise affected.

Table 10 Summary of maximum predicted noise level and highly affected receivers for the Evening period.

Maximum cumulative predicted $L_{Aeq,\ 15\ minute}$ noise level	86 dB(A)
Number of highly noise affected receivers (>75 dB)	19

With reference to the CNVS, the number of senstive receivers classified in each impact class for each assessment period are summarised in the following tables.

Table 11 Summary of NML exceedance ranges for standard hours.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	33
Clearly Audible	10 <= 20 dB above NML	12
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 12 Summary of NML exceedance ranges for outside standard hours - weekend.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	33
Clearly Audible	10 <= 20 dB above NML	12
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 13 Summary of NML exceedance ranges for outside standard hours - evenings.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	33
Clearly Audible	10 <= 20 dB above NML	12

Impact class	Predicted noise level	Predicted number of receivers
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 14 Summary of NML exceedance ranges for outside standard hours - nights.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	117
Clearly Audible	10 <= 20 dB above NML	12
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

In the event works are planned for more than two consecutive nights, sleep disturbance has been considered. Table 15 summarises the number of residents predicted to exceed the sleep disturbance screening criterion. Further analysis is also provided to indicate the number of receivers expected to be woken, at LAmax noise levels greater than 65 dBA.

Where exceedances of the awakening criteria are predicted, additional care should be taken, and mitigation measures implemented in line with the CNVS.

Table 15 Summary of predicted exceedances of sleep disturbance screening criterion and awakening criterion.

Criterion	Predicted number of receivers
Potentially Sleep Disturbed (exceed RBL + 15 screening criterion)	0
Exceed 65 dBA awakening criterion	0

3.3 Vibration

The CNVS requires attended vibration measurements at commencement of vibration generating activities to confirm vibration levels satisfy the criteria for that activity.

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. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

Based on the proposed work locations and selected equipment, indicative exceedances of the vibration criteria are summarised in Table 16. The exceedances are based on recommended minimum working distances from vibration intensive plant given in Appendix D of the Construction Noise and Vibration Strategy (Transport for NSW 2019). Vibration impacts for each sensitive receiver are listed in Appendix C.

Table 16 Predicted exceedances of vibration criteria

Impact classification	Number of potentially affected receivers
Human comfort	0
Cosmetic damage	0
Heritage structure	0

4 Controls and safeguards

The Project represents a risk of adverse impacts on sensitive receivers, particularly when working close to the project boundary and outside approved hours.

Where short term noise impacts are unavoidable, mitigation measures described in the project construction environment management plan should be implemented together with the recommendations in in Table 14.

Table 17 and additional mitigation measures for each receiver identified in Appendix B and summarised in Table 14.

Table 17 Standard mitigation measures

Community consultation	• Potentially affected receivers will be notified of OOH works in accordance with project requirements. • Where practicable, works will be scheduled to not conflict with major student examination periods, church congregation times, and other sensitive periods identified through community consultation.
Site induction	• All workers will be inducted to the project prior to commencing work and will be cognisant of their noise and vibration obligations under the CNVMP.
Behavioural practices	• Avoid swearing and unnecessary shouting or loud radios onsite. • Avoid dropping materials from height.
Equipment selection	• Priority given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable. • The noise levels of plant and equipment would meet the maximum noise requirements of the CNVS.
Use and siting of plant	• Locate compounds away from sensitive receivers and discourage access from local roads. • Plant used intermittently to be throttled down or shut down. • Noise-emitting plant to be directed away from sensitive receivers where possible. • Stationary plant should be located behind a structure or enclosed if practicable. • Deliveries should be made as far as practical from sensitive receivers. Dedicated loading/unloading sites should be shielded where possible, if close to receivers. • Plan traffic flow, parking and loading/unloading areas to minimise reversing. • Avoid compression breaking on approach to the site. • Where additional activities or plant may result in marginal noise increases and speed works up, consider concentrating activities at one location and complete works as quickly as possible.
Non-tonal reversing alarms.	• Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Noise monitoring	• Monitoring should be completed to verify the assumptions of this CNVIS regarding estimated equipment noise emissions and to ensure compliance with the CNVS.
Vibration monitoring	• Attended vibration measurements should be completed at commencement of vibration generating activities predicted to occur within safe working distances for cosmetic damage. • Where monitoring demonstrates maximum levels exceeded, consider alternative methodologies/equipment
Implement any project specific mitigation measures	
1	Mitigation mesasures as per Project NVMP & DNVIS.

Table 18 Additional mitigation measures

Code	Measure	Description
AA	Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.
M	Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, 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 receiver have 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 has been exceeded so that additional management measures may be implemented.
IB	Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
LB	Letterbox drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.
RO	Respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.
PC	Phone calls	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Appendix A Proposed activities and associated sound power levels

Section 1 - Stage 2 - NDD & Pavement Removal

NDD and removal of pavement is required to be lifted to allow for the discharge route piping.
5/06/2023 8:00:49 PM - 10/06/2023 5:00:38 AM

Equipment	Quantity	Usage	Reduction	SWL
Excavator (06 tonne)	1	40 %	0	90
Tipper Truck	1	30 %	0	93
Vacc truck	1	50 %	0	109
Bogies	1	30 %	0	95
Daymakers / Lighting plant	1	100 %	0	93
Light vehicle	1	10 %	0	75

Activity Sound Power Level: 109
* includes 5 dB penalty for potentially annoying characteristics in line with the ICNG

Appendix B Map showing predicted noise impacts by impact class

Appendix C Detailed predictions

C.1 Noise

Construction noise impact statement

Assessment: George St Water Discharge Route					NML, LAeq, 15 minute				Sleep, LAmax		Predicted noise level, dBA		Exceedance summary										
														Exceed NML by (dB):				Exceed sleep disturbance by (dB):		Impact classification			
NCA	Rec	Address	Flr	Land use	Day	O/day	Eve	Night	Screen	Awake	Cumulative LAeq, 15 minute	LMax	Highly Affected?	Day	O/day	Eve	Night	Screen	Awake	Day	O/day	Eve	Night
NCA03	745603	"52 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745602	"52 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			75	82		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745117	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	2	COM	70	70	70	70			84	92	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745116	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	1	COM	70	70	70	70			86	93	Y	16	16	16	16	-	16	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745115	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	9	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745114	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	8	COM	70	70	70	70			75	83		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745113	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	7	COM	70	70	70	70			76	83	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745112	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	6	COM	70	70	70	70			77	84	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745111	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	5	COM	70	70	70	70			78	86	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	745110	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	4	COM	70	70	70	70			80	88	Y	10	10	10	10	-	10	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745109	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	3	COM	70	70	70	70			82	90	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744968	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	9	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744967	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	8	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744966	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	7	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744965	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	6	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744964	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	5	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744963	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	4	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744691	"48 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744689	"48 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744688	"48 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744687	"48 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744686	"48 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744680	"244 CHURCH ST, PARRAMATTA"	1	EDU	55	55	55	55			59	67		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744541	"94 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			81	89	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744540	"94 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			82	89	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744539	"94 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			82	89	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744506	"2 HORWOOD PL, PARRAMATTA"	4	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744505	"2 HORWOOD PL, PARRAMATTA"	3	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744504	"2 HORWOOD PL, PARRAMATTA"	2	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744503	"2 HORWOOD PL, PARRAMATTA"	1	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744210	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	13	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744209	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744208	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			73	81		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable

NCA03	744207	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744206	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744205	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			75	83	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	744204	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			76	84	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	744203	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			77	85	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	744202	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			79	86	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	744201	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			80	88	Y	10	10	10	10	-	10	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744200	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			82	90	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744199	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			84	91	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744198	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			85	93	Y	15	15	15	15	-	15	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744197	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	14	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744104	"THE ROXY ARCADE 73 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			86	93	Y	16	16	16	16	-	16	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible

C.2 Vibration

NCA	Receiver	Address	Land use	Vibration Impact

Construction noise and vibration impact statement

George St Water Discharge Route			
Project	SMW WTP - Westmead and Parramatta		
Client	Gamuda Laing O'Rourke Consortium		
Assessment Date	02/03/2023	Assessment Id	PARRA-036
Proposed start date	5/06/2023	Proposed end date	10/06/2023

Contents

Acoustic terms and acronyms

AA	Acoustic Advisor
AMM	Additional mitigation measures – applicable where standard measures have been implemented and NML is still expected to be exceeded.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
ICNG	Interim Construction Noise Guideline (Department of Environment and Climate Change 2009)
NCA	Noise Catchment Area
Noise level statistics	L_{A90} - The A-weighted sound pressure level exceeded 90% of the monitoring period. This is considered to represent the background noise. L_{Aeq} - The equivalent continuous A-weighted noise level—the level of noise equivalent to the energy average of noise levels occurring over a measurement period. L_{A1} – The A-weighted sound pressure level exceeded 1% of the monitoring period. L_{Amax} – The maximum A-weighted noise level associated with the measurement period.
NML	Noise Management Level
PPV	Peak Particle Velocity – Measurement of ground-borne vibration in units of mm/s
RBL	Rating Background Level - a single figure that represents the background noise level for assessment purposes
ROL	Road Occupancy Licence – granted by Transport for NSW and required for any activity likely to impact on traffic flow.
SWL	Sound Power Level - The A-weighted sound power level is a logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
SPL	Sound pressure level - This is the level of noise, usually expressed in dB(A), as measured by a standard sound level meter with a pressure microphone. The sound pressure level in dB(A) gives a close indication of the subjective loudness of noise. A technical definition for the sound pressure level, in decibels, is 20 times the logarithm (base 10) of the ratio of any two quantities related to a given sound pressure to a reference pressure (typically 20 µPa equivalent to 0 dB).
Tonal noise	Noise with perceptible and definite pitch or tone
VDV	Vibration dose value – used when assessing intermittent vibration as it is sensitive to peaks in vibration acceleration and accumulates the vibration energy received over the daytime and night-time periods

1 Introduction

1.1 Overview

The Sydney Metro Western Tunnelling Package is being delivered by the Gamuda Australia and Laing O'Rourke Consortium (GLC) and includes twin nine-kilometre tunnels between Sydney Olympic Park and Westmead, excavation of two new metro stations, and a stabling and maintenance facility at Clyde (the Project).

During the Project, there is potential for nearby sensitive receivers to experience adverse impacts relating to noise and vibration. The project's Noise and Vibration Management Sub Plan (NVMP) was developed to satisfy the project's Conditions of Approval (CoA) and addresses the assessment and management of noise and vibration impacts during construction.

Under the NVMP, KNOWnoise™, a project-specific noise prediction tool, has been developed to prepare a Construction noise and vibration impact statement (CNIS) for site and activity-specific noise works and provide ongoing risk analysis during project delivery and for when out-of-hours work is proposed (as per the Project's out-of-hours protocol).

This CNIS has been prepared using KNOWnoise™ and addresses activities for construction of the Westmead and Parramatta station boxes and utilities corridor between the two sites, as illustrated in Figure 1.

The structure of this CNIS includes:

- Section 1.2 – Construction works and hours with justification for these works in Section 1.3
- Section 2 – Existing environment
- Section 3 – Assessment framework including noise and vibration management levels
- Section 4 – Construction noise assessment
- Section 5 – Mitigation and management, including consultation

1.2 Planned works

GLC plans to carry out the works described in Appendix A, which lists each assessed activity, its timing and proposed equipment.

1.3 Justification of the works

In line with the Interim Construction Noise Guidelines (DECC 2009), justification is typically required to work outside approved construction hours. These situations may involve low impact or emergency works and works under an out-of-hours work protocol.

GLC proposes the works subject to this assessment outside approved construction hours for the following reason.

- Works are required to be completed outside of standard construction hours as (a) the applicable council permits and Road Occupancy License (ROL) for access to the footpaths and road network will only be issued for non-peak periods (i.e. weekend, evening and night works) along Smith Street; and (b) works are required to be completed without obstructing access to the public and adjacent commercial premises).

Figure 1 Location map

1 Existing environment

1.1 Sensitive receivers

The Westmead study area is centred on the Westmead metro station construction site. The construction site is located to the south of the existing Westmead Station and is bound by Hawkesbury Road to the west, Hassall Street to the east and Baily Street to the south.

Existing noise levels in this study area are generally controlled by transportation noise from the surrounding road network and existing rail line. The area surrounding the construction site is generally suburban and the nearest receivers are residential.

The Parramatta study area is centred on the Parramatta metro station construction site. The construction site is located between George Street and Macquarie Street, and between Church Street and Smith Street.

Existing noise levels in this study area are controlled by road traffic noise and general urban hum associated with the CBD. As with any CBD, existing noise levels and are relatively high during the daytime, evening and night-time. The area surrounding the construction site is mainly commercial and the nearest receivers are close to the boundary of the site. The nearest receivers are typically of general office or retail use.

1.2 Noise catchment areas

To facilitate the assessment of noise impacts from the project and to apply representative Noise Management Levels (NMLs) to all receivers, receivers adjacent to the Westmead and Parramatta sites have been divided into Noise Catchment Areas (NCAs). The Westmead site contains two noise catchments (NCA01 and NCA02) and NCA03 comprises the Parramatta CBD.

NCAs group individual sensitive receivers by representative traits such as existing noise environment and potential exposure to noise and vibration from the Project.

NCAs established as part of the EIS are summarised in Table 1 and illustrated in Figure 1. Background noise monitoring has been completed as part of the EIS to apply appropriate NML to each NCA.

Table 1 Summary of work areas, Noise Catchment Areas and land uses

NCA	Location	Description
1	Westmead	North of the existing rail corridor in Westmead and mainly residential. 'Other sensitive' receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.
2		South of the existing rail corridor and mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.
3	Parramatta	Covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many 'other sensitive' receivers in this catchment, including Western Sydney University, Arthur Phillip High School, Parramatta Public School, and a number of hotels and places of worship.

2 Assessment framework

2.1 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2. Use of power saws, rock breakers, drills and other tonal or impulsive activities are defined as annoying under the Interim Construction Noise Guideline (ICNG) and are 'highly noise intensive works'.

Table 2 Approved construction hours

CoA	Construction activity	Monday to Friday	Saturday	Sunday / Public holiday
D35	Approved construction	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work (unless approved under EPL or out-of-hours work protocol)
D36	Highly noise intensive works	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work (unless approved under EPL or out-of-hours work protocol)

Notes:

1. if continuously, then not exceeding three hours, with a minimum cessation of work of not less than one hour.

2.2 Noise assessment criteria

2.2.1 Construction noise

The ICNG describes noise in excess of the background level as potentially having an adverse impact on sensitive receivers and increasing the likelihood of complaint. During standard construction hours, where construction noise is within 10 dB(A) of the RBL, impacts would be acceptable.

Where construction noise is more than 10 dB(A) above the RBL during standard construction hours, a residential receiver is considered noise affected and the proponent should undertake all reasonable and feasible steps necessary to manage the impact and consult with the affected community.

Above a $L_{Aeq,\ 15\ minute}$ noise level of 75 dB(A), a receiver is highly affected, requiring consideration of additional mitigation measures including alternative accommodation in the night period.

Outside standard construction hours, construction noise at a residential receiver more than 5 dB(A) above the RBL is taken to be noise affected. Table 1 (reproduced from Table 2 of the ICNG) sets out the NMLs for residences and how they are to be applied.

In addition, annoying noise such as rock hammers, impact piling, or other impulsive noise sources usually result in greater annoyance than continuous construction noise. A 5 dB(A) penalty is applicable to such activities prior to comparison with the NMLs.

2.2.2 Sleep disturbance

The CNVS requires maximum noise levels to be analysed in terms of the extent and number of times the maximum noise exceeds specific noise trigger levels, in general accordance with the Noise Policy for Industry (NPfI) (EPA 2017). These triggers are:

- LAeq, 15 minute 40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and the
- LAmax 52 dBA or the prevailing RBL plus 15 dB, whichever is greater.

The NPfI also recommends the DECCW (2011) Road Noise Policy (RNP) be reviewed for further risk assessment. The RNP recommends maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep and one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

Table 3 Residential noise management levels

Time of day	NML $L_{Aeq\ (15\ min)}$ *	How to apply
Standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Other sensitive land uses, such as schools and offices, typically find noise from construction disruptive when the properties are being used (such as during work and school times). The noise management levels for non-residential receivers set in accordance with the Interim Construction Noise Guideline are provided in Table 4. These levels apply only during hours when the non-residential premises are being used.

The difference between an internal noise level and the external noise level is about 10 dB(A), which provides a conservative assumption that windows are open for ventilation. Buildings where windows are fixed or cannot otherwise be opened may achieve a greater noise level performance.

Table 4 Non-residential sensitive land uses noise management levels

Land use	Noise assessment location	NML ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Places of worship		
Active recreation areas (such as sporting activities and activities which generate their own noise or focus for participants)	External	65
Passive recreation areas (contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External	60
Industrial premises	External	75
Office, retail outlets	External	70

2.3 Project construction noise management levels

The Project specific construction noise management levels for residential receivers have been established in line with the ICNG, based on the RBLs relevant to each NCA. These are presented in Table 5. NMLs for non-residential sensitive receivers are described in Table 4.

Table 5 Project specific construction NMLs

NCA	Noise Management Level, $L_{Aeq\ 15\ minute}$						
	Approved hours		Outside approved hours				
	Noise affected	Highly noise affected	Day	Evening	Night	Sleep disturbance (CNVS)	
						$L_{Aeq,\ 15\ minute}$	L_{Amax}
1	58	75	53	51	46	46	56
2	59	75	54	52	42	42	52
3	68	75	63	58	48	48	58

As part of planning for out of hours works, standard mitigation measures, as described in the CNVMP, are implemented where reasonable and feasible. However, after these measures have been applied, noise and vibration levels may continue to exceed the NMLs.

In this case, additional mitigation measures outlined in the CNVS, which largely focus on engagement with affected sensitive receivers, should be implemented where reasonable and feasible, unless other agreements are in place with the impacted receiver.

Triggers and additional mitigation measures for airborne noise are taken from the Project's OOHW Protocol and summarised in Table 6. Further details of specific additional mitigation measures are described in the CNVS.

Table 6 Triggers for additional mitigation measures – Airborne noise (Sydney Metro 2020)

Construction hours	Class	dB above NML	Additional management measures
Approved hours Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	N	0 to 10	-
	CA	10 to 20	LB
	MI	20 to 30	LB, M, SN
	HI	>30	LB, M, SN
Evening Monday – Friday: 6pm – 10pm Saturday: 7am – 8am, 6pm – 10pm Sunday / PH: 8am – 6pm	N	0 to 10	LB
	CA	10 to 20	LB, M
	MI	20 to 30	LB, M, SN, RO
	HI	> 30	LB, M, SN, IB, PC, RO
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am) Sunday / PH: 6pm –7am	N	0 to 10	LB
	CA	10 to 20	LB, M, SN, RO
	MI	20 to 30	LB, M, SN, IB, PC, RO, AA
	HI	> 30	LB, M, SN, IB, PC, RO, AA

Notes: PC = Phone Calls and emails
M = Monitoring
IB = Individual briefings
AA = Alternative accommodation
SN = Specific notification
LB = Letterbox drops
RO = Project specific respite offer

N = Noticeable CA = Clearly audible MI Moderately intrusive HI = Highly intrusive

2.4 Vibration management

2.4.1 Human comfort

When assessing human exposure to construction-related vibration, the CNVS requires vibration goals to be established using *Environmental Noise Management Assessing Vibration: A Technical Guideline* (DECC 2006), which provides criteria for the assessment of vibration impacts on humans.

Construction activities typically generate vibration of an intermittent nature, which is assessed using a Vibration Dose Value (VDV). Acceptable values of vibration doses are presented in Table 7 for sensitive receivers.

Table 7 VDV Vibration criteria

Receiver type	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings – 16 hour day (7am to 11pm)[1]	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings – 8 hour night (11pm to 7am)[1]	0.13	0.26	0.51

Note 1: Day time and night time as described in BS6472:1992 (as referenced in the CNVS), i.e. a daytime period of 16 h or a night time period of 8 h, for example 23.00 h to 07.00 h.

2.4.2 Buildings

Potential building damage from construction vibration requires the application of values in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings* Part 2. These values are presented in Table 8 and relate to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Table 8 Guideline values for vibration velocity for the effects of short-term vibration on structures (BS 7385).

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz to 50 mm/s at 40 Hz and above

Where vibration may give rise to magnification due to resonance, especially at lower frequencies where lower guide values apply, the guide values may be reduced by 50%. The CNVS describes rock breaking/hammering and sheet piling activities as having potential to cause dynamic loading in some structures (e.g. residences).

For activity involving rock breakers, piling rigs, vibratory rollers, excavators, vibration predominantly occurs at frequencies in the 10 Hz to 100 Hz range. On this basis, a conservative vibration damage screening level is:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

2.4.3 Heritage

Heritage buildings and structures would be assessed under a conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150). Where vibration levels at heritage items are identified as exceeding this screening level, structural assessment would be completed by the Project team to confirm the structure's sensitivity to vibration. If a heritage building or structure is found to be structurally unsound (following inspection) the conservative criterion would stand. Where the structure is suitably sound, the guideline values from Table 8 would be applicable.

2.4.4 Additional mitigation measures

The CNVS recommends additional mitigation measures where all standard mitigation measures to minimise vibration at the nearest receivers have been implemented and vibration is still predicted to exceed the maximum guideline values. The Additional Mitigation Measures Matrix (AMMM) for vibration from the CNVS is presented in Table 9.

Table 9 Additional Vibration Mitigation Measures (CNVS)

Construction hours	Mitigation measures where predicted vibration levels exceed maximum levels
Approved hours Monday – Friday: 7am – 6pm, Saturday: 8am to 6pm	LB, M, RO
Evening Monday – Friday: 6pm – 10pm; Saturday: 7am – 8am, 6pm – 10pm; Sunday / PH: 8am – 6pm	LB, M, IB, PC, RO, SN
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am); Sunday / PH: 6pm –7am	LB, M, IB, PC, RO, SN, AA

3 Impact assessment

3.1 Modelling method

Predictions of noise impacts were performed using KNOWnoise™, a project-specific noise assessment tool developed by Hutchison Weller for the CTP Project. KNOWnoise calculates the maximum $L_{Aeq,15minute}$ noise level for each identified receiver for each proposed activity using predictions from SoundPlan noise modelling software. Predictions include geometric spreading, air and ground absorptions as well as topographical and structural screening and reflection.

The following components were incorporated in the model:

- Topography – Based on terrain data of 1 m resolution.
- Individual sensitive receivers – Worst-affected façade of each building to 700 metres from the works
- Construction noise sources –Activities and equipment provided by GLC were included in the noise model as individual sources across the nominated work areas for each activity. The maximum predicted LAeq noise level within each work area was identified for each receiver.
- Cumulative impacts – all activities with overlapping time periods are included in cumulative results
- Source height – construction noise sources assumed to be at 1.5 metres above ground level.
- Ground Absorption – Ground assumed to be mixed hard and soft with absorption factor of 0.5
- Meteorology –worst-case meteorological conditions (gentle breeze from source to receiver and stable conditions).
- Residential building structures are included in the model, meaning screening provided by neighboring houses is considered.
- Results are shown for all floors of assessed buildings with the worst-case façade result assumed for the whole floor.

Equipment proposed to be used for OOHW activities together with estimated sound power levels for each item are summarised in Appendix A.

The sound power levels and ultimate predicted noise levels will depend on the number of plant items operating at any one time and their precise location relative to a sensitive receiver. In practice, the predicted levels will vary due to plant moving around the site and not operating intensively or concurrently for a 15 minute assessment period. Shielding and reflection provided by buildings will also vary as plant moves around the site. Therefore, predicted noise levels are conservative.

3.2 Predicted noise levels

Predicted impact classes for the Evening period are illustrated graphically in Appendix B. Each identified receiver in the study area has been coloured to highlight the predicted level of impact.

Detailed predicted noise levels for each potentially affected receiver are presented Appendix C.

Table 10 presents the worst-case predicted noise level of 78 dB(A) during the works, resulting in 5 receivers classed as highly noise affected.

Table 10 Summary of maximum predicted noise level and highly affected receivers for the Evening period.

Maximum cumulative predicted $L_{Aeq,\ 15\ minute}$ noise level	78 dB(A)
Number of highly noise affected receivers (>75 dB)	5

With reference to the CNVS, the number of senstive receivers classified in each impact class for each assessment period are summarised in the following tables.

Table 11 Summary of NML exceedance ranges for standard hours.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	14
Clearly Audible	10 <= 20 dB above NML	0
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 12 Summary of NML exceedance ranges for outside standard hours - weekend.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	14
Clearly Audible	10 <= 20 dB above NML	0
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 13 Summary of NML exceedance ranges for outside standard hours - evenings.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	14
Clearly Audible	10 <= 20 dB above NML	0

Impact class	Predicted noise level	Predicted number of receivers
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 14 Summary of NML exceedance ranges for outside standard hours - nights.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	14
Clearly Audible	10 <= 20 dB above NML	0
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

In the event works are planned for more than two consecutive nights, sleep disturbance has been considered. Table 15 summarises the number of residents predicted to exceed the sleep disturbance screening criterion. Further analysis is also provided to indicate the number of receivers expected to be woken, at LAmax noise levels greater than 65 dBA.

Where exceedances of the awakening criteria are predicted, additional care should be taken, and mitigation measures implemented in line with the CNVS.

Table 15 Summary of predicted exceedances of sleep disturbance screening criterion and awakening criterion.

Criterion	Predicted number of receivers
Potentially Sleep Disturbed (exceed RBL + 15 screening criterion)	0
Exceed 65 dBA awakening criterion	0

3.3 Vibration

The CNVS requires attended vibration measurements at commencement of vibration generating activities to confirm vibration levels satisfy the criteria for that activity.

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. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

Based on the proposed work locations and selected equipment, indicative exceedances of the vibration criteria are summarised in Table 16. The exceedances are based on recommended minimum working distances from vibration intensive plant given in Appendix D of the Construction Noise and Vibration Strategy (Transport for NSW 2019). Vibration impacts for each sensitive receiver are listed in Appendix C.

Table 16 Predicted exceedances of vibration criteria

Impact classification	Number of potentially affected receivers
Human comfort	14
Cosmetic damage	0
Heritage structure	0

4 Controls and safeguards

The Project represents a risk of adverse impacts on sensitive receivers, particularly when working close to the project boundary and outside approved hours.

Where short term noise impacts are unavoidable, mitigation measures described in the project construction environment management plan should be implemented together with the recommendations in in Table 14.

Table 17 and additional mitigation measures for each receiver identified in Appendix B and summarised in Table 14.

Table 17 Standard mitigation measures

Community consultation	• Potentially affected receivers will be notified of OOH works in accordance with project requirements. • Where practicable, works will be scheduled to not conflict with major student examination periods, church congregation times, and other sensitive periods identified through community consultation.
Site induction	• All workers will be inducted to the project prior to commencing work and will be cognisant of their noise and vibration obligations under the CNVMP.
Behavioural practices	• Avoid swearing and unnecessary shouting or loud radios onsite. • Avoid dropping materials from height.
Equipment selection	• Priority given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable. • The noise levels of plant and equipment would meet the maximum noise requirements of the CNVS.
Use and siting of plant	• Locate compounds away from sensitive receivers and discourage access from local roads. • Plant used intermittently to be throttled down or shut down. • Noise-emitting plant to be directed away from sensitive receivers where possible. • Stationary plant should be located behind a structure or enclosed if practicable. • Deliveries should be made as far as practical from sensitive receivers. Dedicated loading/unloading sites should be shielded where possible, if close to receivers. • Plan traffic flow, parking and loading/unloading areas to minimise reversing. • Avoid compression breaking on approach to the site. • Where additional activities or plant may result in marginal noise increases and speed works up, consider concentrating activities at one location and complete works as quickly as possible.
Non-tonal reversing alarms.	• Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Noise monitoring	• Monitoring should be completed to verify the assumptions of this CNVIS regarding estimated equipment noise emissions and to ensure compliance with the CNVS.
Vibration monitoring	• Attended vibration measurements should be completed at commencement of vibration generating activities predicted to occur within safe working distances for cosmetic damage. • Where monitoring demonstrates maximum levels exceeded, consider alternative methodologies/equipment
Implement any project specific mitigation measures	
1	Mitigation mesasures as per Project NVMP & DNVIS.

Table 18 Additional mitigation measures

Code	Measure	Description
AA	Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.
M	Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, 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 receiver have 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 has been exceeded so that additional management measures may be implemented.
IB	Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
LB	Letterbox drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.
RO	Respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.
PC	Phone calls	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Appendix A Proposed activities and associated sound power levels

Section 1 - Stage 3 - Installation of Pipeline & Reinstatement of Surface

Installation of pipeline, backfill excavations, compact and reinstate surface with asphalt.
5/06/2023 8:00:03 PM - 10/06/2023 5:00:33 AM

Equipment	Quantity	Usage	Reduction	SWL
Bogies	1	30 %	0	95
Plate compactor (small e.g. 60kg)	1	30 %	0	99
Tipper Truck	1	30 %	0	93
Daymakers / Lighting plant	1	100 %	0	93
Light vehicle	1	10 %	0	75

Activity Sound Power Level: 102
* includes 5 dB penalty for potentially annoying characteristics in line with the ICNG

Appendix B Map showing predicted noise impacts by impact class

Appendix C Detailed predictions

C.1 Noise

Assessment: George St Water Discharge Route					NML, LAeq, 15 minute				Sleep, LAmax		Predicted noise level, dBA		Exceedance summary										
														Exceed NML by (dB):				Exceed sleep disturbance by (dB):		Impact classification			
NCA	Rec	Address	Flr	Land use	Day	O/day	Eve	Night	Screen	Awake	Cumulative LAeq, 15 minute	LMax	Highly Affected?	Day	O/day	Eve	Night	Screen	Awake	Day	O/day	Eve	Night
NCA03	745117	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	2	COM	70	70	70	70			76	84	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745116	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	1	COM	70	70	70	70			78	85	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	745111	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	5	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745110	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	4	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745109	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	3	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744541	"94 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			73	81		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744540	"94 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744539	"94 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744202	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744201	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744200	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744199	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			76	83	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	744198	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			77	85	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	744104	"THE ROXY ARCADE 73 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			78	85	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable

C.2 Vibration

NCA	Receiver	Address	Land use	Vibration Impact
NCA03	745117	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	COM	Human Comfort
NCA03	745116	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	COM	Human Comfort
NCA03	745111	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	COM	Human Comfort
NCA03	745110	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	COM	Human Comfort
NCA03	745109	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	COM	Human Comfort
NCA03	744541	"94 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744540	"94 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744539	"94 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744202	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744201	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744200	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744199	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744198	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744104	"THE ROXY ARCADE 73 GEORGE ST, PARRAMATTA"	COM	Human Comfort

Construction noise and vibration impact statement

George St Water Discharge Route			
Project	SMW WTP - Westmead and Parramatta		
Client	Gamuda Laing O'Rourke Consortium		
Assessment Date	02/03/2023	Assessment Id	PARRA-036
Proposed start date	12/06/2023	Proposed end date	16/06/2023

Contents

Acoustic terms and acronyms

AA	Acoustic Advisor
AMM	Additional mitigation measures – applicable where standard measures have been implemented and NML is still expected to be exceeded.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
ICNG	Interim Construction Noise Guideline (Department of Environment and Climate Change 2009)
NCA	Noise Catchment Area
Noise level statistics	L_{A90} - The A-weighted sound pressure level exceeded 90% of the monitoring period. This is considered to represent the background noise. L_{Aeq} - The equivalent continuous A-weighted noise level—the level of noise equivalent to the energy average of noise levels occurring over a measurement period. L_{A1} – The A-weighted sound pressure level exceeded 1% of the monitoring period. L_{Amax} – The maximum A-weighted noise level associated with the measurement period.
NML	Noise Management Level
PPV	Peak Particle Velocity – Measurement of ground-borne vibration in units of mm/s
RBL	Rating Background Level - a single figure that represents the background noise level for assessment purposes
ROL	Road Occupancy Licence – granted by Transport for NSW and required for any activity likely to impact on traffic flow.
SWL	Sound Power Level - The A-weighted sound power level is a logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
SPL	Sound pressure level - This is the level of noise, usually expressed in dB(A), as measured by a standard sound level meter with a pressure microphone. The sound pressure level in dB(A) gives a close indication of the subjective loudness of noise. A technical definition for the sound pressure level, in decibels, is 20 times the logarithm (base 10) of the ratio of any two quantities related to a given sound pressure to a reference pressure (typically 20 µPa equivalent to 0 dB).
Tonal noise	Noise with perceptible and definite pitch or tone
VDV	Vibration dose value – used when assessing intermittent vibration as it is sensitive to peaks in vibration acceleration and accumulates the vibration energy received over the daytime and night-time periods

1 Introduction

1.1 Overview

The Sydney Metro Western Tunnelling Package is being delivered by the Gamuda Australia and Laing O'Rourke Consortium (GLC) and includes twin nine-kilometre tunnels between Sydney Olympic Park and Westmead, excavation of two new metro stations, and a stabling and maintenance facility at Clyde (the Project).

During the Project, there is potential for nearby sensitive receivers to experience adverse impacts relating to noise and vibration. The project's Noise and Vibration Management Sub Plan (NVMP) was developed to satisfy the project's Conditions of Approval (CoA) and addresses the assessment and management of noise and vibration impacts during construction.

Under the NVMP, KNOWnoise™, a project-specific noise prediction tool, has been developed to prepare a Construction noise and vibration impact statement (CNIS) for site and activity-specific noise works and provide ongoing risk analysis during project delivery and for when out-of-hours work is proposed (as per the Project's out-of-hours protocol).

This CNIS has been prepared using KNOWnoise™ and addresses activities for construction of the Westmead and Parramatta station boxes and utilities corridor between the two sites, as illustrated in Figure 1.

The structure of this CNIS includes:

- Section 1.2 – Construction works and hours with justification for these works in Section 1.3
- Section 2 – Existing environment
- Section 3 – Assessment framework including noise and vibration management levels
- Section 4 – Construction noise assessment
- Section 5 – Mitigation and management, including consultation

1.2 Planned works

GLC plans to carry out the works described in Appendix A, which lists each assessed activity, its timing and proposed equipment.

1.3 Justification of the works

In line with the Interim Construction Noise Guidelines (DECC 2009), justification is typically required to work outside approved construction hours. These situations may involve low impact or emergency works and works under an out-of-hours work protocol.

GLC proposes the works subject to this assessment outside approved construction hours for the following reason.

- Works are required to be completed outside of standard construction hours as (a) the applicable council permits and Road Occupancy License (ROL) for access to the footpaths and road network will only be issued for non-peak periods (i.e. weekend, evening and night works) along Smith Street; and (b) works are required to be completed without obstructing access to the public and adjacent commercial premises).

Figure 1 Location map

1 Existing environment

1.1 Sensitive receivers

The Westmead study area is centred on the Westmead metro station construction site. The construction site is located to the south of the existing Westmead Station and is bound by Hawkesbury Road to the west, Hassall Street to the east and Baily Street to the south.

Existing noise levels in this study area are generally controlled by transportation noise from the surrounding road network and existing rail line. The area surrounding the construction site is generally suburban and the nearest receivers are residential.

The Parramatta study area is centred on the Parramatta metro station construction site. The construction site is located between George Street and Macquarie Street, and between Church Street and Smith Street.

Existing noise levels in this study area are controlled by road traffic noise and general urban hum associated with the CBD. As with any CBD, existing noise levels and are relatively high during the daytime, evening and night-time. The area surrounding the construction site is mainly commercial and the nearest receivers are close to the boundary of the site. The nearest receivers are typically of general office or retail use.

1.2 Noise catchment areas

To facilitate the assessment of noise impacts from the project and to apply representative Noise Management Levels (NMLs) to all receivers, receivers adjacent to the Westmead and Parramatta sites have been divided into Noise Catchment Areas (NCAs). The Westmead site contains two noise catchments (NCA01 and NCA02) and NCA03 comprises the Parramatta CBD.

NCAs group individual sensitive receivers by representative traits such as existing noise environment and potential exposure to noise and vibration from the Project.

NCAs established as part of the EIS are summarised in Table 1 and illustrated in Figure 1. Background noise monitoring has been completed as part of the EIS to apply appropriate NML to each NCA.

Table 1 Summary of work areas, Noise Catchment Areas and land uses

NCA	Location	Description
1	Westmead	North of the existing rail corridor in Westmead and mainly residential. 'Other sensitive' receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.
2		South of the existing rail corridor and mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.
3	Parramatta	Covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many 'other sensitive' receivers in this catchment, including Western Sydney University, Arthur Phillip High School, Parramatta Public School, and a number of hotels and places of worship.

2 Assessment framework

2.1 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2. Use of power saws, rock breakers, drills and other tonal or impulsive activities are defined as annoying under the Interim Construction Noise Guideline (ICNG) and are 'highly noise intensive works'.

Table 2 Approved construction hours

CoA	Construction activity	Monday to Friday	Saturday	Sunday / Public holiday
D35	Approved construction	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work (unless approved under EPL or out-of-hours work protocol)
D36	Highly noise intensive works	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work (unless approved under EPL or out-of-hours work protocol)

Notes:

1. if continuously, then not exceeding three hours, with a minimum cessation of work of not less than one hour.

2.2 Noise assessment criteria

2.2.1 Construction noise

The ICNG describes noise in excess of the background level as potentially having an adverse impact on sensitive receivers and increasing the likelihood of complaint. During standard construction hours, where construction noise is within 10 dB(A) of the RBL, impacts would be acceptable.

Where construction noise is more than 10 dB(A) above the RBL during standard construction hours, a residential receiver is considered noise affected and the proponent should undertake all reasonable and feasible steps necessary to manage the impact and consult with the affected community.

Above a $L_{Aeq,\ 15\ minute}$ noise level of 75 dB(A), a receiver is highly affected, requiring consideration of additional mitigation measures including alternative accommodation in the night period.

Outside standard construction hours, construction noise at a residential receiver more than 5 dB(A) above the RBL is taken to be noise affected. Table 1 (reproduced from Table 2 of the ICNG) sets out the NMLs for residences and how they are to be applied.

In addition, annoying noise such as rock hammers, impact piling, or other impulsive noise sources usually result in greater annoyance than continuous construction noise. A 5 dB(A) penalty is applicable to such activities prior to comparison with the NMLs.

2.2.2 Sleep disturbance

The CNVS requires maximum noise levels to be analysed in terms of the extent and number of times the maximum noise exceeds specific noise trigger levels, in general accordance with the Noise Policy for Industry (NPfI) (EPA 2017). These triggers are:

- LAeq, 15 minute 40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and the
- LAmax 52 dBA or the prevailing RBL plus 15 dB, whichever is greater.

The NPfI also recommends the DECCW (2011) Road Noise Policy (RNP) be reviewed for further risk assessment. The RNP recommends maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep and one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

Table 3 Residential noise management levels

Time of day	NML $L_{Aeq\ (15\ min)}$ *	How to apply
Standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Other sensitive land uses, such as schools and offices, typically find noise from construction disruptive when the properties are being used (such as during work and school times). The noise management levels for non-residential receivers set in accordance with the Interim Construction Noise Guideline are provided in Table 4. These levels apply only during hours when the non-residential premises are being used.

The difference between an internal noise level and the external noise level is about 10 dB(A), which provides a conservative assumption that windows are open for ventilation. Buildings where windows are fixed or cannot otherwise be opened may achieve a greater noise level performance.

Table 4 Non-residential sensitive land uses noise management levels

Land use	Noise assessment location	NML ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Places of worship		
Active recreation areas (such as sporting activities and activities which generate their own noise or focus for participants)	External	65
Passive recreation areas (contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External	60
Industrial premises	External	75
Office, retail outlets	External	70

2.3 Project construction noise management levels

The Project specific construction noise management levels for residential receivers have been established in line with the ICNG, based on the RBLs relevant to each NCA. These are presented in Table 5. NMLs for non-residential sensitive receivers are described in Table 4.

Table 5 Project specific construction NMLs

NCA	Noise Management Level, $L_{Aeq\ 15\ minute}$						
	Approved hours		Outside approved hours				
	Noise affected	Highly noise affected	Day	Evening	Night	Sleep disturbance (CNVS)	
						$L_{Aeq,\ 15\ minute}$	L_{Amax}
1	58	75	53	51	46	46	56
2	59	75	54	52	42	42	52
3	68	75	63	58	48	48	58

As part of planning for out of hours works, standard mitigation measures, as described in the CNVMP, are implemented where reasonable and feasible. However, after these measures have been applied, noise and vibration levels may continue to exceed the NMLs.

In this case, additional mitigation measures outlined in the CNVS, which largely focus on engagement with affected sensitive receivers, should be implemented where reasonable and feasible, unless other agreements are in place with the impacted receiver.

Triggers and additional mitigation measures for airborne noise are taken from the Project's OOHW Protocol and summarised in Table 6. Further details of specific additional mitigation measures are described in the CNVS.

Table 6 Triggers for additional mitigation measures – Airborne noise (Sydney Metro 2020)

Construction hours	Class	dB above NML	Additional management measures
Approved hours Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	N	0 to 10	-
	CA	10 to 20	LB
	MI	20 to 30	LB, M, SN
	HI	>30	LB, M, SN
Evening Monday – Friday: 6pm – 10pm Saturday: 7am – 8am, 6pm – 10pm Sunday / PH: 8am – 6pm	N	0 to 10	LB
	CA	10 to 20	LB, M
	MI	20 to 30	LB, M, SN, RO
	HI	> 30	LB, M, SN, IB, PC, RO
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am) Sunday / PH: 6pm –7am	N	0 to 10	LB
	CA	10 to 20	LB, M, SN, RO
	MI	20 to 30	LB, M, SN, IB, PC, RO, AA
	HI	> 30	LB, M, SN, IB, PC, RO, AA

Notes: PC = Phone Calls and emails; M = Monitoring; IB = Individual briefings; AA = Alternative accommodation; SN = Specific notification; LB = Letterbox drops; RO = Project specific respite offer

N = Noticeable CA = Clearly audible MI Moderately intrusive HI = Highly intrusive

2.4 Vibration management

2.4.1 Human comfort

When assessing human exposure to construction-related vibration, the CNVS requires vibration goals to be established using *Environmental Noise Management Assessing Vibration: A Technical Guideline* (DECC 2006), which provides criteria for the assessment of vibration impacts on humans.

Construction activities typically generate vibration of an intermittent nature, which is assessed using a Vibration Dose Value (VDV). Acceptable values of vibration doses are presented in Table 7 for sensitive receivers.

Table 7 VDV Vibration criteria

Receiver type	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings – 16 hour day (7am to 11pm)[1]	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings – 8 hour night (11pm to 7am)[1]	0.13	0.26	0.51

Note 1: Day time and night time as described in BS6472:1992 (as referenced in the CNVS), i.e. a daytime period of 16 h or a night time period of 8 h, for example 23.00 h to 07.00 h.

2.4.2 Buildings

Potential building damage from construction vibration requires the application of values in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings* Part 2. These values are presented in Table 8 and relate to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Table 8 Guideline values for vibration velocity for the effects of short-term vibration on structures (BS 7385).

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz to 50 mm/s at 40 Hz and above

Where vibration may give rise to magnification due to resonance, especially at lower frequencies where lower guide values apply, the guide values may be reduced by 50%. The CNVS describes rock breaking/hammering and sheet piling activities as having potential to cause dynamic loading in some structures (e.g. residences).

For activity involving rock breakers, piling rigs, vibratory rollers, excavators, vibration predominantly occurs at frequencies in the 10 Hz to 100 Hz range. On this basis, a conservative vibration damage screening level is:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

2.4.3 Heritage

Heritage buildings and structures would be assessed under a conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150). Where vibration levels at heritage items are identified as exceeding this screening level, structural assessment would be completed by the Project team to confirm the structure's sensitivity to vibration. If a heritage building or structure is found to be structurally unsound (following inspection) the conservative criterion would stand. Where the structure is suitably sound, the guideline values from Table 8 would be applicable.

2.4.4 Additional mitigation measures

The CNVS recommends additional mitigation measures where all standard mitigation measures to minimise vibration at the nearest receivers have been implemented and vibration is still predicted to exceed the maximum guideline values. The Additional Mitigation Measures Matrix (AMMM) for vibration from the CNVS is presented in Table 9.

Table 9 Additional Vibration Mitigation Measures (CNVS)

Construction hours	Mitigation measures where predicted vibration levels exceed maximum levels
Approved hours Monday – Friday: 7am – 6pm, Saturday: 8am to 6pm	LB, M, RO
Evening Monday – Friday: 6pm – 10pm; Saturday: 7am – 8am, 6pm – 10pm; Sunday / PH: 8am – 6pm	LB, M, IB, PC, RO, SN
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am); Sunday / PH: 6pm –7am	LB, M, IB, PC, RO, SN, AA

3 Impact assessment

3.1 Modelling method

Predictions of noise impacts were performed using KNOWnoise™, a project-specific noise assessment tool developed by Hutchison Weller for the CTP Project. KNOWnoise calculates the maximum $L_{Aeq,15minute}$ noise level for each identified receiver for each proposed activity using predictions from SoundPlan noise modelling software. Predictions include geometric spreading, air and ground absorptions as well as topographical and structural screening and reflection.

The following components were incorporated in the model:

- Topography – Based on terrain data of 1 m resolution.
- Individual sensitive receivers – Worst-affected façade of each building to 700 metres from the works
- Construction noise sources –Activities and equipment provided by GLC were included in the noise model as individual sources across the nominated work areas for each activity. The maximum predicted LAeq noise level within each work area was identified for each receiver.
- Cumulative impacts – all activities with overlapping time periods are included in cumulative results
- Source height – construction noise sources assumed to be at 1.5 metres above ground level.
- Ground Absorption – Ground assumed to be mixed hard and soft with absorption factor of 0.5
- Meteorology –worst-case meteorological conditions (gentle breeze from source to receiver and stable conditions).
- Residential building structures are included in the model, meaning screening provided by neighboring houses is considered.
- Results are shown for all floors of assessed buildings with the worst-case façade result assumed for the whole floor.

Equipment proposed to be used for OOHW activities together with estimated sound power levels for each item are summarised in Appendix A.

The sound power levels and ultimate predicted noise levels will depend on the number of plant items operating at any one time and their precise location relative to a sensitive receiver. In practice, the predicted levels will vary due to plant moving around the site and not operating intensively or concurrently for a 15 minute assessment period. Shielding and reflection provided by buildings will also vary as plant moves around the site. Therefore, predicted noise levels are conservative.

3.2 Predicted noise levels

Predicted impact classes for the Evening period are illustrated graphically in Appendix B. Each identified receiver in the study area has been coloured to highlight the predicted level of impact.

Detailed predicted noise levels for each potentially affected receiver are presented Appendix C.

Table 10 presents the worst-case predicted noise level of 89 dB(A) during the works, resulting in 60 receivers classed as highly noise affected.

Table 10 Summary of maximum predicted noise level and highly affected receivers for the Evening period.

Maximum cumulative predicted $L_{Aeq,\ 15\ minute}$ noise level	89 dB(A)
Number of highly noise affected receivers (>75 dB)	60

With reference to the CNVS, the number of senstive receivers classified in each impact class for each assessment period are summarised in the following tables.

Table 11 Summary of NML exceedance ranges for standard hours.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	97
Clearly Audible	10 <= 20 dB above NML	25
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 12 Summary of NML exceedance ranges for outside standard hours - weekend.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	97
Clearly Audible	10 <= 20 dB above NML	25
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 13 Summary of NML exceedance ranges for outside standard hours - evenings.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	97
Clearly Audible	10 <= 20 dB above NML	25

Impact class	Predicted noise level	Predicted number of receivers
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 14 Summary of NML exceedance ranges for outside standard hours - nights.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	181
Clearly Audible	10 <= 20 dB above NML	25
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

In the event works are planned for more than two consecutive nights, sleep disturbance has been considered. Table 15 summarises the number of residents predicted to exceed the sleep disturbance screening criterion. Further analysis is also provided to indicate the number of receivers expected to be woken, at LAmax noise levels greater than 65 dBA.

Where exceedances of the awakening criteria are predicted, additional care should be taken, and mitigation measures implemented in line with the CNVS.

Table 15 Summary of predicted exceedances of sleep disturbance screening criterion and awakening criterion.

Criterion	Predicted number of receivers
Potentially Sleep Disturbed (exceed RBL + 15 screening criterion)	0
Exceed 65 dBA awakening criterion	0

3.3 Vibration

The CNVS requires attended vibration measurements at commencement of vibration generating activities to confirm vibration levels satisfy the criteria for that activity.

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. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

Based on the proposed work locations and selected equipment, indicative exceedances of the vibration criteria are summarised in Table 16. The exceedances are based on recommended minimum working distances from vibration intensive plant given in Appendix D of the Construction Noise and Vibration Strategy (Transport for NSW 2019). Vibration impacts for each sensitive receiver are listed in Appendix C.

Table 16 Predicted exceedances of vibration criteria

Impact classification	Number of potentially affected receivers
Human comfort	0
Cosmetic damage	0
Heritage structure	0

4 Controls and safeguards

The Project represents a risk of adverse impacts on sensitive receivers, particularly when working close to the project boundary and outside approved hours.

Where short term noise impacts are unavoidable, mitigation measures described in the project construction environment management plan should be implemented together with the recommendations in in Table 14.

Table 17 and additional mitigation measures for each receiver identified in Appendix B and summarised in Table 14.

Table 17 Standard mitigation measures

Community consultation	• Potentially affected receivers will be notified of OOH works in accordance with project requirements. • Where practicable, works will be scheduled to not conflict with major student examination periods, church congregation times, and other sensitive periods identified through community consultation.
Site induction	• All workers will be inducted to the project prior to commencing work and will be cognisant of their noise and vibration obligations under the CNVMP.
Behavioural practices	• Avoid swearing and unnecessary shouting or loud radios onsite. • Avoid dropping materials from height.
Equipment selection	• Priority given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable. • The noise levels of plant and equipment would meet the maximum noise requirements of the CNVS.
Use and siting of plant	• Locate compounds away from sensitive receivers and discourage access from local roads. • Plant used intermittently to be throttled down or shut down. • Noise-emitting plant to be directed away from sensitive receivers where possible. • Stationary plant should be located behind a structure or enclosed if practicable. • Deliveries should be made as far as practical from sensitive receivers. Dedicated loading/unloading sites should be shielded where possible, if close to receivers. • Plan traffic flow, parking and loading/unloading areas to minimise reversing. • Avoid compression breaking on approach to the site. • Where additional activities or plant may result in marginal noise increases and speed works up, consider concentrating activities at one location and complete works as quickly as possible.
Non-tonal reversing alarms.	• Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Noise monitoring	• Monitoring should be completed to verify the assumptions of this CNVIS regarding estimated equipment noise emissions and to ensure compliance with the CNVS.
Vibration monitoring	• Attended vibration measurements should be completed at commencement of vibration generating activities predicted to occur within safe working distances for cosmetic damage. • Where monitoring demonstrates maximum levels exceeded, consider alternative methodologies/equipment
Implement any project specific mitigation measures	
1	Mitigation mesasures as per Project NVMP & DNVIS.

Table 18 Additional mitigation measures

Code	Measure	Description
AA	Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.
M	Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, 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 receiver have 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 has been exceeded so that additional management measures may be implemented.
IB	Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
LB	Letterbox drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.
RO	Respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.
PC	Phone calls	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Appendix A Proposed activities and associated sound power levels

Section 2 - Stage 1 - Saw Cutting Pavement

Pipeline located below ground. Saw cutting will be required for the removal of the footpath and roadway pavement.
12/06/2023 8:00:18 PM - 16/06/2023 10:00:42 PM

Equipment	Quantity	Usage	Reduction	SWL
Concrete Saw (Std)*	1	30 %	3	111
Daymakers / Lighting plant	1	100 %	0	93
Light vehicle	1	10 %	0	75

Activity Sound Power Level: 111

* includes 5 dB penalty for potentially annoying characteristics in line with the ICNG

Appendix B Map showing predicted noise impacts by impact class

Appendix C Detailed predictions

C.1 Noise

GAMUDA Australia

LAING O'ROURKE

Construction noise impact statement

Assessment: George St Water Discharge Route					NML, LAeq, 15 minute				Sleep, LAmax		Predicted noise level, dBA		Exceedance summary										
														Exceed NML by (dB):				Exceed sleep disturbance by (dB):		Impact classification			
NCA	Rec	Address	Flr	Land use	Day	O/day	Eve	Night	Screen	Awake	Cumulative LAeq, 15 minute	LMax	Highly Affected?	Day	O/day	Eve	Night	Screen	Awake	Day	O/day	Eve	Night
NCA03	747083	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	21	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747082	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	20	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747081	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	19	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	747080	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	18	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	747079	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	17	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	747078	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	16	COM	70	70	70	70			72	78		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	747077	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	15	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	747076	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	14	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	747075	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	13	COM	70	70	70	70			73	79		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	747074	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	747073	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	747072	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			75	80		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	747071	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	747070	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	747069	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	747068	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			79	84	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	747067	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			80	85	Y	10	10	10	10	-	10	Noticable	Noticable	Noticable	Noticable
NCA03	747066	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			81	87	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	747065	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			83	88	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	747064	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			84	90	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	747063	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			85	90	Y	15	15	15	15	-	15	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746886	"1 BARRACK LANE, PARRAMATTA"	5	COM	70	70	70	70			79	84	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746885	"1 BARRACK LANE, PARRAMATTA"	4	COM	70	70	70	70			80	86	Y	10	10	10	10	-	10	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746884	"1 BARRACK LANE, PARRAMATTA"	3	COM	70	70	70	70			82	87	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746883	"1 BARRACK LANE, PARRAMATTA"	2	COM	70	70	70	70			83	88	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746882	"1 BARRACK LANE, PARRAMATTA"	1	COM	70	70	70	70			84	89	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746252	"169 MACQUARIE ST, PARRAMATTA"	21	EDU	55	55	55	55			61	67		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746251	"169 MACQUARIE ST, PARRAMATTA"	20	EDU	55	55	55	55			61	67		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746250	"169 MACQUARIE ST, PARRAMATTA"	19	EDU	55	55	55	55			61	67		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746249	"169 MACQUARIE ST, PARRAMATTA"	18	EDU	55	55	55	55			61	67		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746248	"169 MACQUARIE ST, PARRAMATTA"	17	EDU	55	55	55	55			62	67		7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746247	"169 MACQUARIE ST, PARRAMATTA"	16	EDU	55	55	55	55			62	67		7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746246	"169 MACQUARIE ST, PARRAMATTA"	15	EDU	55	55	55	55			61	66		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable

NCA03	746245	"169 MACQUARIE ST, PARRAMATTA"	14	EDU	55	55	55	55			61	66		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746244	"169 MACQUARIE ST, PARRAMATTA"	13	EDU	55	55	55	55			61	66		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746243	"169 MACQUARIE ST, PARRAMATTA"	12	EDU	55	55	55	55			61	66		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746242	"169 MACQUARIE ST, PARRAMATTA"	11	EDU	55	55	55	55			60	66		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746241	"169 MACQUARIE ST, PARRAMATTA"	10	EDU	55	55	55	55			60	65		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746240	"169 MACQUARIE ST, PARRAMATTA"	9	EDU	55	55	55	55			60	65		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746239	"169 MACQUARIE ST, PARRAMATTA"	8	EDU	55	55	55	55			60	65		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746238	"169 MACQUARIE ST, PARRAMATTA"	7	EDU	55	55	55	55			59	64		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746237	"169 MACQUARIE ST, PARRAMATTA"	6	EDU	55	55	55	55			59	64		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746236	"169 MACQUARIE ST, PARRAMATTA"	5	EDU	55	55	55	55			59	64		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746235	"169 MACQUARIE ST, PARRAMATTA"	4	EDU	55	55	55	55			58	64		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746234	"169 MACQUARIE ST, PARRAMATTA"	3	EDU	55	55	55	55			58	63		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746233	"169 MACQUARIE ST, PARRAMATTA"	2	EDU	55	55	55	55			58	63		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746232	"169 MACQUARIE ST, PARRAMATTA"	1	EDU	55	55	55	55			58	63		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746047	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			73	79		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746046	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746045	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746044	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			75	80		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746043	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			75	80	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746042	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746041	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			76	82	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746040	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746039	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746038	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746037	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			79	84	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746036	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			79	84	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	745631	"SE 1 LEVEL 1 100 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745630	"SE 1 LEVEL 1 100 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745117	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	2	COM	70	70	70	70			86	91	Y	16	16	16	16	-	16	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745116	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	1	COM	70	70	70	70			87	92	Y	17	17	17	17	-	17	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745115	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	9	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745114	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	8	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745113	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	7	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	745112	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	6	COM	70	70	70	70			79	84	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	745111	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	5	COM	70	70	70	70			80	85	Y	10	10	10	10	-	10	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745110	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	4	COM	70	70	70	70			82	87	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible

Construction noise impact statement

NCA03	745109	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	3	COM	70	70	70	70			84	89	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745068	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	13	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745067	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	12	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745066	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	11	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745065	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	10	COM	70	70	70	70			75	80		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745064	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	9	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745063	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	8	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745062	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	7	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	745061	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	6	COM	70	70	70	70			79	84	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	745060	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	5	COM	70	70	70	70			80	85	Y	10	10	10	10	-	10	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745059	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	4	COM	70	70	70	70			82	87	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745058	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	3	COM	70	70	70	70			84	89	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745057	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	2	COM	70	70	70	70			86	91	Y	16	16	16	16	-	16	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745056	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	1	COM	70	70	70	70			88	93	Y	18	18	18	18	-	18	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745055	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	15	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745054	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	14	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744970	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	11	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744969	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	10	COM	70	70	70	70			71	77		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744968	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	9	COM	70	70	70	70			71	77		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744967	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	8	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744966	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	7	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744965	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	6	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744964	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	5	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744889	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744888	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744887	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			75	80		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	744886	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			75	81	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	744885	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	744884	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	744883	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			78	84	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	744882	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			80	85	Y	10	10	10	10	-	10	Noticable	Noticable	Noticable	Noticable
NCA03	744881	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			82	87	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744880	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			84	89	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744879	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			86	91	Y	16	16	16	16	-	16	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744878	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			88	93	Y	18	18	18	18	-	18	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744541	"94 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			85	90	Y	15	15	15	15	-	15	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible

NCA03	744540	"94 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			88	93	Y	18	18	18	18	-	18	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744539	"94 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			89	95	Y	19	19	19	19	-	19	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744210	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	13	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744209	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744208	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744207	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744206	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			75	80		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	744205	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			75	80	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	744204	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	744203	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	744202	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	744201	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	744200	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	744199	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	744198	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	744197	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	14	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744104	"THE ROXY ARCADE 73 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable

C.2 Vibration

NCA	Receiver	Address	Land use	Vibration Impact

George St Water Discharge Route

Project	SMW WTP - Westmead and Parramatta		
Client	Gamuda Laing O'Rourke Consortium		
Assessment Date	02/03/2023	Assessment Id	PARRA-036
Proposed start date	12/06/2023	Proposed end date	17/06/2023

Contents

Acoustic terms and acronyms

AA	Acoustic Advisor
AMM	Additional mitigation measures – applicable where standard measures have been implemented and NML is still expected to be exceeded.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
ICNG	Interim Construction Noise Guideline (Department of Environment and Climate Change 2009)
NCA	Noise Catchment Area
Noise level statistics	L_{A90} - The A-weighted sound pressure level exceeded 90% of the monitoring period. This is considered to represent the background noise. L_{Aeq} - The equivalent continuous A-weighted noise level—the level of noise equivalent to the energy average of noise levels occurring over a measurement period. L_{A1} – The A-weighted sound pressure level exceeded 1% of the monitoring period. L_{Amax} – The maximum A-weighted noise level associated with the measurement period.
NML	Noise Management Level
PPV	Peak Particle Velocity – Measurement of ground-borne vibration in units of mm/s
RBL	Rating Background Level - a single figure that represents the background noise level for assessment purposes
ROL	Road Occupancy Licence – granted by Transport for NSW and required for any activity likely to impact on traffic flow.
SWL	Sound Power Level - The A-weighted sound power level is a logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
SPL	Sound pressure level - This is the level of noise, usually expressed in dB(A), as measured by a standard sound level meter with a pressure microphone. The sound pressure level in dB(A) gives a close indication of the subjective loudness of noise. A technical definition for the sound pressure level, in decibels, is 20 times the logarithm (base 10) of the ratio of any two quantities related to a given sound pressure to a reference pressure (typically 20 µPa equivalent to 0 dB).
Tonal noise	Noise with perceptible and definite pitch or tone
VDV	Vibration dose value – used when assessing intermittent vibration as it is sensitive to peaks in vibration acceleration and accumulates the vibration energy received over the daytime and night-time periods

1 Introduction

1.1 Overview

The Sydney Metro Western Tunnelling Package is being delivered by the Gamuda Australia and Laing O'Rourke Consortium (GLC) and includes twin nine-kilometre tunnels between Sydney Olympic Park and Westmead, excavation of two new metro stations, and a stabling and maintenance facility at Clyde (the Project).

During the Project, there is potential for nearby sensitive receivers to experience adverse impacts relating to noise and vibration. The project's Noise and Vibration Management Sub Plan (NVMP) was developed to satisfy the project's Conditions of Approval (CoA) and addresses the assessment and management of noise and vibration impacts during construction.

Under the NVMP, KNOWnoise™, a project-specific noise prediction tool, has been developed to prepare a Construction noise and vibration impact statement (CNIS) for site and activity-specific noise works and provide ongoing risk analysis during project delivery and for when out-of-hours work is proposed (as per the Project's out-of-hours protocol).

This CNIS has been prepared using KNOWnoise™ and addresses activities for construction of the Westmead and Parramatta station boxes and utilities corridor between the two sites, as illustrated in Figure 1.

The structure of this CNIS includes:

- Section 1.2 – Construction works and hours with justification for these works in Section 1.3
- Section 2 – Existing environment
- Section 3 – Assessment framework including noise and vibration management levels
- Section 4 – Construction noise assessment
- Section 5 – Mitigation and management, including consultation

1.2 Planned works

GLC plans to carry out the works described in Appendix A, which lists each assessed activity, its timing and proposed equipment.

1.3 Justification of the works

In line with the Interim Construction Noise Guidelines (DECC 2009), justification is typically required to work outside approved construction hours. These situations may involve low impact or emergency works and works under an out-of-hours work protocol.

GLC proposes the works subject to this assessment outside approved construction hours for the following reason.

- Works are required to be completed outside of standard construction hours as (a) the applicable council permits and Road Occupancy License (ROL) for access to the footpaths and road network will only be issued for non-peak periods (i.e. weekend, evening and night works) along Smith Street; and (b) works are required to be completed without obstructing access to the public and adjacent commercial premises).

Figure 1 Location map

1 Existing environment

1.1 Sensitive receivers

The Westmead study area is centred on the Westmead metro station construction site. The construction site is located to the south of the existing Westmead Station and is bound by Hawkesbury Road to the west, Hassall Street to the east and Baily Street to the south.

Existing noise levels in this study area are generally controlled by transportation noise from the surrounding road network and existing rail line. The area surrounding the construction site is generally suburban and the nearest receivers are residential.

The Parramatta study area is centred on the Parramatta metro station construction site. The construction site is located between George Street and Macquarie Street, and between Church Street and Smith Street.

Existing noise levels in this study area are controlled by road traffic noise and general urban hum associated with the CBD. As with any CBD, existing noise levels and are relatively high during the daytime, evening and night-time. The area surrounding the construction site is mainly commercial and the nearest receivers are close to the boundary of the site. The nearest receivers are typically of general office or retail use.

1.2 Noise catchment areas

To facilitate the assessment of noise impacts from the project and to apply representative Noise Management Levels (NMLs) to all receivers, receivers adjacent to the Westmead and Parramatta sites have been divided into Noise Catchment Areas (NCAs). The Westmead site contains two noise catchments (NCA01 and NCA02) and NCA03 comprises the Parramatta CBD.

NCAs group individual sensitive receivers by representative traits such as existing noise environment and potential exposure to noise and vibration from the Project.

NCAs established as part of the EIS are summarised in Table 1 and illustrated in Figure 1. Background noise monitoring has been completed as part of the EIS to apply appropriate NML to each NCA.

Table 1 Summary of work areas, Noise Catchment Areas and land uses

NCA	Location	Description
1	Westmead	North of the existing rail corridor in Westmead and mainly residential. 'Other sensitive' receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.
2		South of the existing rail corridor and mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.
3	Parramatta	Covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many 'other sensitive' receivers in this catchment, including Western Sydney University, Arthur Phillip High School, Parramatta Public School, and a number of hotels and places of worship.

2 Assessment framework

2.1 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2. Use of power saws, rock breakers, drills and other tonal or impulsive activities are defined as annoying under the Interim Construction Noise Guideline (ICNG) and are 'highly noise intensive works'.

Table 2 Approved construction hours

CoA	Construction activity	Monday to Friday	Saturday	Sunday / Public holiday
D35	Approved construction	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work (unless approved under EPL or out-of-hours work protocol)
D36	Highly noise intensive works	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work (unless approved under EPL or out-of-hours work protocol)

Notes:

1. if continuously, then not exceeding three hours, with a minimum cessation of work of not less than one hour.

2.2 Noise assessment criteria

2.2.1 Construction noise

The ICNG describes noise in excess of the background level as potentially having an adverse impact on sensitive receivers and increasing the likelihood of complaint. During standard construction hours, where construction noise is within 10 dB(A) of the RBL, impacts would be acceptable.

Where construction noise is more than 10 dB(A) above the RBL during standard construction hours, a residential receiver is considered noise affected and the proponent should undertake all reasonable and feasible steps necessary to manage the impact and consult with the affected community.

Above a $L_{Aeq,\ 15\ minute}$ noise level of 75 dB(A), a receiver is highly affected, requiring consideration of additional mitigation measures including alternative accommodation in the night period.

Outside standard construction hours, construction noise at a residential receiver more than 5 dB(A) above the RBL is taken to be noise affected. Table 1 (reproduced from Table 2 of the ICNG) sets out the NMLs for residences and how they are to be applied.

In addition, annoying noise such as rock hammers, impact piling, or other impulsive noise sources usually result in greater annoyance than continuous construction noise. A 5 dB(A) penalty is applicable to such activities prior to comparison with the NMLs.

2.2.2 Sleep disturbance

The CNVS requires maximum noise levels to be analysed in terms of the extent and number of times the maximum noise exceeds specific noise trigger levels, in general accordance with the Noise Policy for Industry (NPfI) (EPA 2017). These triggers are:

- LAeq, 15 minute 40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and the
- LAmax 52 dBA or the prevailing RBL plus 15 dB, whichever is greater.

The NPfI also recommends the DECCW (2011) Road Noise Policy (RNP) be reviewed for further risk assessment. The RNP recommends maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep and one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

Table 3 Residential noise management levels

Time of day	NML $L_{Aeq\ (15\ min)}$ *	How to apply
Standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Other sensitive land uses, such as schools and offices, typically find noise from construction disruptive when the properties are being used (such as during work and school times). The noise management levels for non-residential receivers set in accordance with the Interim Construction Noise Guideline are provided in Table 4. These levels apply only during hours when the non-residential premises are being used.

The difference between an internal noise level and the external noise level is about 10 dB(A), which provides a conservative assumption that windows are open for ventilation. Buildings where windows are fixed or cannot otherwise be opened may achieve a greater noise level performance.

Table 4 Non-residential sensitive land uses noise management levels

Land use	Noise assessment location	NML ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Places of worship		
Active recreation areas (such as sporting activities and activities which generate their own noise or focus for participants)	External	65
Passive recreation areas (contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External	60
Industrial premises	External	75
Office, retail outlets	External	70

2.3 Project construction noise management levels

The Project specific construction noise management levels for residential receivers have been established in line with the ICNG, based on the RBLs relevant to each NCA. These are presented in Table 5. NMLs for non-residential sensitive receivers are described in Table 4.

Table 5 Project specific construction NMLs

NCA	Noise Management Level, $L_{Aeq\ 15\ minute}$						
	Approved hours		Outside approved hours				
	Noise affected	Highly noise affected	Day	Evening	Night	Sleep disturbance (CNVS)	
						$L_{Aeq,\ 15\ minute}$	L_{Amax}
1	58	75	53	51	46	46	56
2	59	75	54	52	42	42	52
3	68	75	63	58	48	48	58

As part of planning for out of hours works, standard mitigation measures, as described in the CNVMP, are implemented where reasonable and feasible. However, after these measures have been applied, noise and vibration levels may continue to exceed the NMLs.

In this case, additional mitigation measures outlined in the CNVS, which largely focus on engagement with affected sensitive receivers, should be implemented where reasonable and feasible, unless other agreements are in place with the impacted receiver.

Triggers and additional mitigation measures for airborne noise are taken from the Project's OOHW Protocol and summarised in Table 6. Further details of specific additional mitigation measures are described in the CNVS.

Table 6 Triggers for additional mitigation measures – Airborne noise (Sydney Metro 2020)

Construction hours	Class	dB above NML	Additional management measures
Approved hours Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	N	0 to 10	-
	CA	10 to 20	LB
	MI	20 to 30	LB, M, SN
	HI	>30	LB, M, SN
Evening Monday – Friday: 6pm – 10pm Saturday: 7am – 8am, 6pm – 10pm Sunday / PH: 8am – 6pm	N	0 to 10	LB
	CA	10 to 20	LB, M
	MI	20 to 30	LB, M, SN, RO
	HI	> 30	LB, M, SN, IB, PC, RO
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am) Sunday / PH: 6pm –7am	N	0 to 10	LB
	CA	10 to 20	LB, M, SN, RO
	MI	20 to 30	LB, M, SN, IB, PC, RO, AA
	HI	> 30	LB, M, SN, IB, PC, RO, AA

Notes: PC = Phone Calls and emails
M = Monitoring
IB = Individual briefings
AA = Alternative accommodation
SN = Specific notification
LB = Letterbox drops
RO = Project specific respite offer

N = Noticeable CA = Clearly audible MI Moderately intrusive HI = Highly intrusive

2.4 Vibration management

2.4.1 Human comfort

When assessing human exposure to construction-related vibration, the CNVS requires vibration goals to be established using *Environmental Noise Management Assessing Vibration: A Technical Guideline* (DECC 2006), which provides criteria for the assessment of vibration impacts on humans.

Construction activities typically generate vibration of an intermittent nature, which is assessed using a Vibration Dose Value (VDV). Acceptable values of vibration doses are presented in Table 7 for sensitive receivers.

Table 7 VDV Vibration criteria

Receiver type	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings – 16 hour day (7am to 11pm)[1]	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings – 8 hour night (11pm to 7am)[1]	0.13	0.26	0.51

Note 1: Day time and night time as described in BS6472:1992 (as referenced in the CNVS), i.e. a daytime period of 16 h or a night time period of 8 h, for example 23.00 h to 07.00 h.

2.4.2 Buildings

Potential building damage from construction vibration requires the application of values in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings* Part 2. These values are presented in Table 8 and relate to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Table 8 Guideline values for vibration velocity for the effects of short-term vibration on structures (BS 7385).

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz to 50 mm/s at 40 Hz and above

Where vibration may give rise to magnification due to resonance, especially at lower frequencies where lower guide values apply, the guide values may be reduced by 50%. The CNVS describes rock breaking/hammering and sheet piling activities as having potential to cause dynamic loading in some structures (e.g. residences).

For activity involving rock breakers, piling rigs, vibratory rollers, excavators, vibration predominantly occurs at frequencies in the 10 Hz to 100 Hz range. On this basis, a conservative vibration damage screening level is:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

2.4.3 Heritage

Heritage buildings and structures would be assessed under a conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150). Where vibration levels at heritage items are identified as exceeding this screening level, structural assessment would be completed by the Project team to confirm the structure's sensitivity to vibration. If a heritage building or structure is found to be structurally unsound (following inspection) the conservative criterion would stand. Where the structure is suitably sound, the guideline values from Table 8 would be applicable.

2.4.4 Additional mitigation measures

The CNVS recommends additional mitigation measures where all standard mitigation measures to minimise vibration at the nearest receivers have been implemented and vibration is still predicted to exceed the maximum guideline values. The Additional Mitigation Measures Matrix (AMMM) for vibration from the CNVS is presented in Table 9.

Table 9 Additional Vibration Mitigation Measures (CNVS)

Construction hours	Mitigation measures where predicted vibration levels exceed maximum levels
Approved hours Monday – Friday: 7am – 6pm, Saturday: 8am to 6pm	LB, M, RO
Evening Monday – Friday: 6pm – 10pm; Saturday: 7am – 8am, 6pm – 10pm; Sunday / PH: 8am – 6pm	LB, M, IB, PC, RO, SN
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am); Sunday / PH: 6pm –7am	LB, M, IB, PC, RO, SN, AA

3 Impact assessment

3.1 Modelling method

Predictions of noise impacts were performed using KNOWnoise™, a project-specific noise assessment tool developed by Hutchison Weller for the CTP Project. KNOWnoise calculates the maximum $L_{Aeq,15minute}$ noise level for each identified receiver for each proposed activity using predictions from SoundPlan noise modelling software. Predictions include geometric spreading, air and ground absorptions as well as topographical and structural screening and reflection.

The following components were incorporated in the model:

- Topography – Based on terrain data of 1 m resolution.
- Individual sensitive receivers – Worst-affected façade of each building to 700 metres from the works
- Construction noise sources –Activities and equipment provided by GLC were included in the noise model as individual sources across the nominated work areas for each activity. The maximum predicted LAeq noise level within each work area was identified for each receiver.
- Cumulative impacts – all activities with overlapping time periods are included in cumulative results
- Source height – construction noise sources assumed to be at 1.5 metres above ground level.
- Ground Absorption – Ground assumed to be mixed hard and soft with absorption factor of 0.5
- Meteorology –worst-case meteorological conditions (gentle breeze from source to receiver and stable conditions).
- Residential building structures are included in the model, meaning screening provided by neighboring houses is considered.
- Results are shown for all floors of assessed buildings with the worst-case façade result assumed for the whole floor.

Equipment proposed to be used for OOHW activities together with estimated sound power levels for each item are summarised in Appendix A.

The sound power levels and ultimate predicted noise levels will depend on the number of plant items operating at any one time and their precise location relative to a sensitive receiver. In practice, the predicted levels will vary due to plant moving around the site and not operating intensively or concurrently for a 15 minute assessment period. Shielding and reflection provided by buildings will also vary as plant moves around the site. Therefore, predicted noise levels are conservative.

3.2 Predicted noise levels

Predicted impact classes for the Evening period are illustrated graphically in Appendix B. Each identified receiver in the study area has been coloured to highlight the predicted level of impact.

Detailed predicted noise levels for each potentially affected receiver are presented Appendix C.

Table 10 presents the worst-case predicted noise level of 86 dB(A) during the works, resulting in 45 receivers classed as highly noise affected.

Table 10 Summary of maximum predicted noise level and highly affected receivers for the Evening period.

Maximum cumulative predicted $L_{Aeq,\ 15\ minute}$ noise level	86 dB(A)
Number of highly noise affected receivers (>75 dB)	45

With reference to the CNVS, the number of senstive receivers classified in each impact class for each assessment period are summarised in the following tables.

Table 11 Summary of NML exceedance ranges for standard hours.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	92
Clearly Audible	10 <= 20 dB above NML	20
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 12 Summary of NML exceedance ranges for outside standard hours - weekend.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	92
Clearly Audible	10 <= 20 dB above NML	20
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 13 Summary of NML exceedance ranges for outside standard hours - evenings.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	92
Clearly Audible	10 <= 20 dB above NML	20

Impact class	Predicted noise level	Predicted number of receivers
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 14 Summary of NML exceedance ranges for outside standard hours - nights.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	154
Clearly Audible	10 <= 20 dB above NML	20
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

In the event works are planned for more than two consecutive nights, sleep disturbance has been considered. Table 15 summarises the number of residents predicted to exceed the sleep disturbance screening criterion. Further analysis is also provided to indicate the number of receivers expected to be woken, at LAmax noise levels greater than 65 dBA.

Where exceedances of the awakening criteria are predicted, additional care should be taken, and mitigation measures implemented in line with the CNVS.

Table 15 Summary of predicted exceedances of sleep disturbance screening criterion and awakening criterion.

Criterion	**Predicted number of receivers**
Potentially Sleep Disturbed (exceed RBL + 15 screening criterion)	0
Exceed 65 dBA awakening criterion	0

3.3 Vibration

The CNVS requires attended vibration measurements at commencement of vibration generating activities to confirm vibration levels satisfy the criteria for that activity.

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. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

Based on the proposed work locations and selected equipment, indicative exceedances of the vibration criteria are summarised in Table 16. The exceedances are based on recommended minimum working distances from vibration intensive plant given in Appendix D of the Construction Noise and Vibration Strategy (Transport for NSW 2019). Vibration impacts for each sensitive receiver are listed in Appendix C.

Table 16 Predicted exceedances of vibration criteria

Impact classification	Number of potentially affected receivers
Human comfort	0
Cosmetic damage	0
Heritage structure	0

4 Controls and safeguards

The Project represents a risk of adverse impacts on sensitive receivers, particularly when working close to the project boundary and outside approved hours.

Where short term noise impacts are unavoidable, mitigation measures described in the project construction environment management plan should be implemented together with the recommendations in in Table 14.

Table 17 and additional mitigation measures for each receiver identified in Appendix B and summarised in Table 14.

Table 17 Standard mitigation measures

Community consultation	• Potentially affected receivers will be notified of OOH works in accordance with project requirements. • Where practicable, works will be scheduled to not conflict with major student examination periods, church congregation times, and other sensitive periods identified through community consultation.
Site induction	• All workers will be inducted to the project prior to commencing work and will be cognisant of their noise and vibration obligations under the CNVMP.
Behavioural practices	• Avoid swearing and unnecessary shouting or loud radios onsite. • Avoid dropping materials from height.
Equipment selection	• Priority given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable. • The noise levels of plant and equipment would meet the maximum noise requirements of the CNVS.
Use and siting of plant	• Locate compounds away from sensitive receivers and discourage access from local roads. • Plant used intermittently to be throttled down or shut down. • Noise-emitting plant to be directed away from sensitive receivers where possible. • Stationary plant should be located behind a structure or enclosed if practicable. • Deliveries should be made as far as practical from sensitive receivers. Dedicated loading/unloading sites should be shielded where possible, if close to receivers. • Plan traffic flow, parking and loading/unloading areas to minimise reversing. • Avoid compression breaking on approach to the site. • Where additional activities or plant may result in marginal noise increases and speed works up, consider concentrating activities at one location and complete works as quickly as possible.
Non-tonal reversing alarms.	• Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Noise monitoring	• Monitoring should be completed to verify the assumptions of this CNVIS regarding estimated equipment noise emissions and to ensure compliance with the CNVS.
Vibration monitoring	• Attended vibration measurements should be completed at commencement of vibration generating activities predicted to occur within safe working distances for cosmetic damage. • Where monitoring demonstrates maximum levels exceeded, consider alternative methodologies/equipment
Implement any project specific mitigation measures	
1	Mitigation mesasures as per Project NVMP & DNVIS.

Table 18 Additional mitigation measures

Code	Measure	Description
AA	Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.
M	Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, 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 receiver have 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 has been exceeded so that additional management measures may be implemented.
IB	Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
LB	Letterbox drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.
RO	Respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.
PC	Phone calls	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Appendix A Proposed activities and associated sound power levels

Section 2 - Stage 2 - NDD & Pavement Removal

NDD and removal of pavement is required to be lifted to allow for the discharge route piping.

12/06/2023 8:00:54 PM - 17/06/2023 5:00:10 AM

Equipment	Quantity	Usage	Reduction	SWL
Excavator (06 tonne)	1	40 %	0	90
Tipper Truck	1	30 %	0	93
Vacc truck	1	50 %	0	109
Bogies	1	30 %	0	95
Daymakers / Lighting plant	1	100 %	0	93
Light vehicle	1	10 %	0	75

Activity Sound Power Level: 109

* includes 5 dB penalty for potentially annoying characteristics in line with the ICNG

Appendix B Map showing predicted noise impacts by impact class

Appendix C Detailed predictions

C.1 Noise

Construction noise impact statement

Assessment: George St Water Discharge Route					NML, LAeq, 15 minute				Sleep, LAmax		Predicted noise level, dBA		Exceedance summary										
														Exceed NML by (dB):				Exceed sleep disturbance by (dB):		Impact classification			
NCA	Rec	Address	Flr	Land use	Day	O/day	Eve	Night	Screen	Awake	Cumulative LAeq, 15 minute	LMax	Highly Affected?	Day	O/day	Eve	Night	Screen	Awake	Day	O/day	Eve	Night
NCA03	747081	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	19	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	747080	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	18	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	747079	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	17	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747078	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	16	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747077	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	15	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747076	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	14	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	747075	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	13	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	747074	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	747073	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	747072	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	747071	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	747070	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			75	83	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	747069	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			76	84	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	747068	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			77	85	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	747067	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			79	86	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	747066	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			80	88	Y	10	10	10	10	-	10	Noticable	Noticable	Noticable	Noticable
NCA03	747065	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			82	89	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	747064	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			83	91	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	747063	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			84	91	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746886	"1 BARRACK LANE, PARRAMATTA"	5	COM	70	70	70	70			78	85	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746885	"1 BARRACK LANE, PARRAMATTA"	4	COM	70	70	70	70			79	87	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746884	"1 BARRACK LANE, PARRAMATTA"	3	COM	70	70	70	70			80	88	Y	10	10	10	10	-	10	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746883	"1 BARRACK LANE, PARRAMATTA"	2	COM	70	70	70	70			81	89	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746882	"1 BARRACK LANE, PARRAMATTA"	1	COM	70	70	70	70			82	90	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746252	"169 MACQUARIE ST, PARRAMATTA"	21	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746251	"169 MACQUARIE ST, PARRAMATTA"	20	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746250	"169 MACQUARIE ST, PARRAMATTA"	19	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746249	"169 MACQUARIE ST, PARRAMATTA"	18	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746248	"169 MACQUARIE ST, PARRAMATTA"	17	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746247	"169 MACQUARIE ST, PARRAMATTA"	16	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746246	"169 MACQUARIE ST, PARRAMATTA"	15	EDU	55	55	55	55			60	67		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746245	"169 MACQUARIE ST, PARRAMATTA"	14	EDU	55	55	55	55			60	67		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746244	"169 MACQUARIE ST, PARRAMATTA"	13	EDU	55	55	55	55			59	67		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable

NCA03	746243	"169 MACQUARIE ST, PARRAMATTA"	12	EDU	55	55	55	55			59	67		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746242	"169 MACQUARIE ST, PARRAMATTA"	11	EDU	55	55	55	55			59	67		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746241	"169 MACQUARIE ST, PARRAMATTA"	10	EDU	55	55	55	55			59	66		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746240	"169 MACQUARIE ST, PARRAMATTA"	9	EDU	55	55	55	55			58	66		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746239	"169 MACQUARIE ST, PARRAMATTA"	8	EDU	55	55	55	55			58	66		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746238	"169 MACQUARIE ST, PARRAMATTA"	7	EDU	55	55	55	55			58	65		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746237	"169 MACQUARIE ST, PARRAMATTA"	6	EDU	55	55	55	55			58	65		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746236	"169 MACQUARIE ST, PARRAMATTA"	5	EDU	55	55	55	55			57	65		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746235	"169 MACQUARIE ST, PARRAMATTA"	4	EDU	55	55	55	55			57	65		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746234	"169 MACQUARIE ST, PARRAMATTA"	3	EDU	55	55	55	55			57	64		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746233	"169 MACQUARIE ST, PARRAMATTA"	2	EDU	55	55	55	55			56	64		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746232	"169 MACQUARIE ST, PARRAMATTA"	1	EDU	55	55	55	55			56	64		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746047	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746046	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746045	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746044	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			73	81		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746043	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746042	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746041	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			75	83	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746040	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			76	83	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746039	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			76	84	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746038	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			77	84	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746037	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			77	85	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746036	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			77	85	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745631	"SE 1 LEVEL 1 100 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745630	"SE 1 LEVEL 1 100 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745117	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	2	COM	70	70	70	70			82	90	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745116	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	1	COM	70	70	70	70			83	91	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745115	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	9	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745114	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	8	COM	70	70	70	70			75	83	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745113	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	7	COM	70	70	70	70			76	84	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745112	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	6	COM	70	70	70	70			77	84	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745111	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	5	COM	70	70	70	70			78	86	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	745110	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	4	COM	70	70	70	70			79	87	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	745109	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	3	COM	70	70	70	70			81	88	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745068	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	13	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable

NCA03	745067	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	12	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745066	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	11	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745065	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	10	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745064	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	9	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745063	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	8	COM	70	70	70	70			75	83	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745062	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	7	COM	70	70	70	70			76	84	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745061	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	6	COM	70	70	70	70			77	85	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745060	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	5	COM	70	70	70	70			79	86	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	745059	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	4	COM	70	70	70	70			81	88	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745058	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	3	COM	70	70	70	70			82	90	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745057	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	2	COM	70	70	70	70			85	92	Y	15	15	15	15	-	15	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745056	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	1	COM	70	70	70	70			86	94	Y	16	16	16	16	-	16	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745055	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	15	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745054	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	14	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744967	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	8	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744966	"SE 1 LEVEL 35 SMITH ST, PARRAMATTA"	7	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744889	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744888	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744887	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			73	81		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744886	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744885	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			75	82		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	744884	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			76	83	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	744883	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			77	85	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	744882	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			79	86	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	744881	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			80	88	Y	10	10	10	10	-	10	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744880	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			82	90	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744879	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			85	92	Y	15	15	15	15	-	15	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744878	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			86	94	Y	16	16	16	16	-	16	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744541	"94 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			81	89	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744540	"94 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			82	90	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744539	"94 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			83	91	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744209	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	744208	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744207	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744206	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744205	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable

NCA03	744204	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744203	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744202	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744201	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744200	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744199	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744198	"SE 2 GROUND 80 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable

C.2 Vibration

NCA	Receiver	Address	Land use	Vibration Impact

Construction noise and vibration impact statement

George St Water Discharge Route

Project	SMW WTP - Westmead and Parramatta		
Client	Gamuda Laing O'Rourke Consortium		
Assessment Date	02/03/2023	Assessment Id	PARRA-036
Proposed start date	12/06/2023	Proposed end date	17/06/2023

Contents

Acoustic terms and acronyms

AA	Acoustic Advisor
AMM	Additional mitigation measures – applicable where standard measures have been implemented and NML is still expected to be exceeded.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
ICNG	Interim Construction Noise Guideline (Department of Environment and Climate Change 2009)
NCA	Noise Catchment Area
Noise level statistics	L_{A90} - The A-weighted sound pressure level exceeded 90% of the monitoring period. This is considered to represent the background noise. L_{Aeq} - The equivalent continuous A-weighted noise level—the level of noise equivalent to the energy average of noise levels occurring over a measurement period. L_{A1} – The A-weighted sound pressure level exceeded 1% of the monitoring period. L_{Amax} – The maximum A-weighted noise level associated with the measurement period.
NML	Noise Management Level
PPV	Peak Particle Velocity – Measurement of ground-borne vibration in units of mm/s
RBL	Rating Background Level - a single figure that represents the background noise level for assessment purposes
ROL	Road Occupancy Licence – granted by Transport for NSW and required for any activity likely to impact on traffic flow.
SWL	Sound Power Level - The A-weighted sound power level is a logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
SPL	Sound pressure level - This is the level of noise, usually expressed in dB(A), as measured by a standard sound level meter with a pressure microphone. The sound pressure level in dB(A) gives a close indication of the subjective loudness of noise. A technical definition for the sound pressure level, in decibels, is 20 times the logarithm (base 10) of the ratio of any two quantities related to a given sound pressure to a reference pressure (typically 20 µPa equivalent to 0 dB).
Tonal noise	Noise with perceptible and definite pitch or tone
VDV	Vibration dose value – used when assessing intermittent vibration as it is sensitive to peaks in vibration acceleration and accumulates the vibration energy received over the daytime and night-time periods

1 Introduction

1.1 Overview

The Sydney Metro Western Tunnelling Package is being delivered by the Gamuda Australia and Laing O'Rourke Consortium (GLC) and includes twin nine-kilometre tunnels between Sydney Olympic Park and Westmead, excavation of two new metro stations, and a stabling and maintenance facility at Clyde (the Project).

During the Project, there is potential for nearby sensitive receivers to experience adverse impacts relating to noise and vibration. The project's Noise and Vibration Management Sub Plan (NVMP) was developed to satisfy the project's Conditions of Approval (CoA) and addresses the assessment and management of noise and vibration impacts during construction.

Under the NVMP, KNOWnoise™, a project-specific noise prediction tool, has been developed to prepare a Construction noise and vibration impact statement (CNIS) for site and activity-specific noise works and provide ongoing risk analysis during project delivery and for when out-of-hours work is proposed (as per the Project's out-of-hours protocol).

This CNIS has been prepared using KNOWnoise™ and addresses activities for construction of the Westmead and Parramatta station boxes and utilities corridor between the two sites, as illustrated in Figure 1.

The structure of this CNIS includes:

- Section 1.2 – Construction works and hours with justification for these works in Section 1.3
- Section 2 – Existing environment
- Section 3 – Assessment framework including noise and vibration management levels
- Section 4 – Construction noise assessment
- Section 5 – Mitigation and management, including consultation

1.2 Planned works

GLC plans to carry out the works described in Appendix A, which lists each assessed activity, its timing and proposed equipment.

1.3 Justification of the works

In line with the Interim Construction Noise Guidelines (DECC 2009), justification is typically required to work outside approved construction hours. These situations may involve low impact or emergency works and works under an out-of-hours work protocol.

GLC proposes the works subject to this assessment outside approved construction hours for the following reason.

- Works are required to be completed outside of standard construction hours as (a) the applicable council permits and Road Occupancy License (ROL) for access to the footpaths and road network will only be issued for non-peak periods (i.e. weekend, evening and night works) along Smith Street; and (b) works are required to be completed without obstructing access to the public and adjacent commercial premises).

Figure 1 Location map

1 Existing environment

1.1 Sensitive receivers

The Westmead study area is centred on the Westmead metro station construction site. The construction site is located to the south of the existing Westmead Station and is bound by Hawkesbury Road to the west, Hassall Street to the east and Baily Street to the south.

Existing noise levels in this study area are generally controlled by transportation noise from the surrounding road network and existing rail line. The area surrounding the construction site is generally suburban and the nearest receivers are residential.

The Parramatta study area is centred on the Parramatta metro station construction site. The construction site is located between George Street and Macquarie Street, and between Church Street and Smith Street.

Existing noise levels in this study area are controlled by road traffic noise and general urban hum associated with the CBD. As with any CBD, existing noise levels and are relatively high during the daytime, evening and night-time. The area surrounding the construction site is mainly commercial and the nearest receivers are close to the boundary of the site. The nearest receivers are typically of general office or retail use.

1.2 Noise catchment areas

To facilitate the assessment of noise impacts from the project and to apply representative Noise Management Levels (NMLs) to all receivers, receivers adjacent to the Westmead and Parramatta sites have been divided into Noise Catchment Areas (NCAs). The Westmead site contains two noise catchments (NCA01 and NCA02) and NCA03 comprises the Parramatta CBD.

NCAs group individual sensitive receivers by representative traits such as existing noise environment and potential exposure to noise and vibration from the Project.

NCAs established as part of the EIS are summarised in Table 1 and illustrated in Figure 1. Background noise monitoring has been completed as part of the EIS to apply appropriate NML to each NCA.

Table 1 Summary of work areas, Noise Catchment Areas and land uses

NCA	Location	Description
1	Westmead	North of the existing rail corridor in Westmead and mainly residential. 'Other sensitive' receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.
2		South of the existing rail corridor and mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.
3	Parramatta	Covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many 'other sensitive' receivers in this catchment, including Western Sydney University, Arthur Phillip High School, Parramatta Public School, and a number of hotels and places of worship.

2 Assessment framework

2.1 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2. Use of power saws, rock breakers, drills and other tonal or impulsive activities are defined as annoying under the Interim Construction Noise Guideline (ICNG) and are 'highly noise intensive works'.

Table 2 Approved construction hours

CoA	Construction activity	Monday to Friday	Saturday	Sunday / Public holiday
D35	Approved construction	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work (unless approved under EPL or out-of-hours work protocol)
D36	Highly noise intensive works	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work (unless approved under EPL or out-of-hours work protocol)

Notes:

1. if continuously, then not exceeding three hours, with a minimum cessation of work of not less than one hour.

2.2 Noise assessment criteria

2.2.1 Construction noise

The ICNG describes noise in excess of the background level as potentially having an adverse impact on sensitive receivers and increasing the likelihood of complaint. During standard construction hours, where construction noise is within 10 dB(A) of the RBL, impacts would be acceptable.

Where construction noise is more than 10 dB(A) above the RBL during standard construction hours, a residential receiver is considered noise affected and the proponent should undertake all reasonable and feasible steps necessary to manage the impact and consult with the affected community.

Above a $L_{Aeq,\ 15\ minute}$ noise level of 75 dB(A), a receiver is highly affected, requiring consideration of additional mitigation measures including alternative accommodation in the night period.

Outside standard construction hours, construction noise at a residential receiver more than 5 dB(A) above the RBL is taken to be noise affected. Table 1 (reproduced from Table 2 of the ICNG) sets out the NMLs for residences and how they are to be applied.

In addition, annoying noise such as rock hammers, impact piling, or other impulsive noise sources usually result in greater annoyance than continuous construction noise. A 5 dB(A) penalty is applicable to such activities prior to comparison with the NMLs.

2.2.2 Sleep disturbance

The CNVS requires maximum noise levels to be analysed in terms of the extent and number of times the maximum noise exceeds specific noise trigger levels, in general accordance with the Noise Policy for Industry (NPfI) (EPA 2017). These triggers are:

- LAeq, 15 minute 40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and the
- LAmax 52 dBA or the prevailing RBL plus 15 dB, whichever is greater.

The NPfI also recommends the DECCW (2011) Road Noise Policy (RNP) be reviewed for further risk assessment. The RNP recommends maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep and one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

Table 3 Residential noise management levels

Time of day	NML $L_{Aeq\ (15\ min)}$ *	How to apply
Standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Other sensitive land uses, such as schools and offices, typically find noise from construction disruptive when the properties are being used (such as during work and school times). The noise management levels for non-residential receivers set in accordance with the Interim Construction Noise Guideline are provided in Table 4. These levels apply only during hours when the non-residential premises are being used.

The difference between an internal noise level and the external noise level is about 10 dB(A), which provides a conservative assumption that windows are open for ventilation. Buildings where windows are fixed or cannot otherwise be opened may achieve a greater noise level performance.

Table 4 Non-residential sensitive land uses noise management levels

Land use	Noise assessment location	NML ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Places of worship		
Active recreation areas (such as sporting activities and activities which generate their own noise or focus for participants)	External	65
Passive recreation areas (contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External	60
Industrial premises	External	75
Office, retail outlets	External	70

2.3 Project construction noise management levels

The Project specific construction noise management levels for residential receivers have been established in line with the ICNG, based on the RBLs relevant to each NCA. These are presented in Table 5. NMLs for non-residential sensitive receivers are described in Table 4.

Table 5 Project specific construction NMLs

NCA	Noise Management Level, $L_{Aeq\ 15\ minute}$						
	Approved hours		Outside approved hours				
	Noise affected	Highly noise affected	Day	Evening	Night	Sleep disturbance (CNVS)	
						$L_{Aeq,\ 15\ minute}$	L_{Amax}
1	58	75	53	51	46	46	56
2	59	75	54	52	42	42	52
3	68	75	63	58	48	48	58

As part of planning for out of hours works, standard mitigation measures, as described in the CNVMP, are implemented where reasonable and feasible. However, after these measures have been applied, noise and vibration levels may continue to exceed the NMLs.

In this case, additional mitigation measures outlined in the CNVS, which largely focus on engagement with affected sensitive receivers, should be implemented where reasonable and feasible, unless other agreements are in place with the impacted receiver.

Triggers and additional mitigation measures for airborne noise are taken from the Project's OOHW Protocol and summarised in Table 6. Further details of specific additional mitigation measures are described in the CNVS.

Table 6 Triggers for additional mitigation measures – Airborne noise (Sydney Metro 2020)

Construction hours	Class	dB above NML	Additional management measures
Approved hours Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	N	0 to 10	-
	CA	10 to 20	LB
	MI	20 to 30	LB, M, SN
	HI	>30	LB, M, SN
Evening Monday – Friday: 6pm – 10pm Saturday: 7am – 8am, 6pm – 10pm Sunday / PH: 8am – 6pm	N	0 to 10	LB
	CA	10 to 20	LB, M
	MI	20 to 30	LB, M, SN, RO
	HI	> 30	LB, M, SN, IB, PC, RO
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am) Sunday / PH: 6pm –7am	N	0 to 10	LB
	CA	10 to 20	LB, M, SN, RO
	MI	20 to 30	LB, M, SN, IB, PC, RO, AA
	HI	> 30	LB, M, SN, IB, PC, RO, AA

Notes: PC = Phone Calls and emails
M = Monitoring
IB = Individual briefings
AA = Alternative accommodation
SN = Specific notification
LB = Letterbox drops
RO = Project specific respite offer

N = Noticeable CA = Clearly audible MI Moderately intrusive HI = Highly intrusive

2.4 Vibration management

2.4.1 Human comfort

When assessing human exposure to construction-related vibration, the CNVS requires vibration goals to be established using *Environmental Noise Management Assessing Vibration: A Technical Guideline* (DECC 2006), which provides criteria for the assessment of vibration impacts on humans.

Construction activities typically generate vibration of an intermittent nature, which is assessed using a Vibration Dose Value (VDV). Acceptable values of vibration doses are presented in Table 7 for sensitive receivers.

Table 7 VDV Vibration criteria

Receiver type	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings – 16 hour day (7am to 11pm)[1]	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings – 8 hour night (11pm to 7am)[1]	0.13	0.26	0.51

Note 1: Day time and night time as described in BS6472:1992 (as referenced in the CNVS), i.e. a daytime period of 16 h or a night time period of 8 h, for example 23.00 h to 07.00 h.

2.4.2 Buildings

Potential building damage from construction vibration requires the application of values in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings* Part 2. These values are presented in Table 8 and relate to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Table 8 Guideline values for vibration velocity for the effects of short-term vibration on structures (BS 7385).

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz to 50 mm/s at 40 Hz and above

Where vibration may give rise to magnification due to resonance, especially at lower frequencies where lower guide values apply, the guide values may be reduced by 50%. The CNVS describes rock breaking/hammering and sheet piling activities as having potential to cause dynamic loading in some structures (e.g. residences).

For activity involving rock breakers, piling rigs, vibratory rollers, excavators, vibration predominantly occurs at frequencies in the 10 Hz to 100 Hz range. On this basis, a conservative vibration damage screening level is:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

2.4.3 Heritage

Heritage buildings and structures would be assessed under a conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150). Where vibration levels at heritage items are identified as exceeding this screening level, structural assessment would be completed by the Project team to confirm the structure's sensitivity to vibration. If a heritage building or structure is found to be structurally unsound (following inspection) the conservative criterion would stand. Where the structure is suitably sound, the guideline values from Table 8 would be applicable.

2.4.4 Additional mitigation measures

The CNVS recommends additional mitigation measures where all standard mitigation measures to minimise vibration at the nearest receivers have been implemented and vibration is still predicted to exceed the maximum guideline values. The Additional Mitigation Measures Matrix (AMMM) for vibration from the CNVS is presented in Table 9.

Table 9 Additional Vibration Mitigation Measures (CNVS)

Construction hours	Mitigation measures where predicted vibration levels exceed maximum levels
Approved hours Monday – Friday: 7am – 6pm, Saturday: 8am to 6pm	LB, M, RO
Evening Monday – Friday: 6pm – 10pm; Saturday: 7am – 8am, 6pm – 10pm; Sunday / PH: 8am – 6pm	LB, M, IB, PC, RO, SN
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am); Sunday / PH: 6pm –7am	LB, M, IB, PC, RO, SN, AA

3 Impact assessment

3.1 Modelling method

Predictions of noise impacts were performed using KNOWnoise™, a project-specific noise assessment tool developed by Hutchison Weller for the CTP Project. KNOWnoise calculates the maximum $L_{Aeq,15minute}$ noise level for each identified receiver for each proposed activity using predictions from SoundPlan noise modelling software. Predictions include geometric spreading, air and ground absorptions as well as topographical and structural screening and reflection.

The following components were incorporated in the model:

- Topography – Based on terrain data of 1 m resolution.
- Individual sensitive receivers – Worst-affected façade of each building to 700 metres from the works
- Construction noise sources –Activities and equipment provided by GLC were included in the noise model as individual sources across the nominated work areas for each activity. The maximum predicted LAeq noise level within each work area was identified for each receiver.
- Cumulative impacts – all activities with overlapping time periods are included in cumulative results
- Source height – construction noise sources assumed to be at 1.5 metres above ground level.
- Ground Absorption – Ground assumed to be mixed hard and soft with absorption factor of 0.5
- Meteorology –worst-case meteorological conditions (gentle breeze from source to receiver and stable conditions).
- Residential building structures are included in the model, meaning screening provided by neighboring houses is considered.
- Results are shown for all floors of assessed buildings with the worst-case façade result assumed for the whole floor.

Equipment proposed to be used for OOHW activities together with estimated sound power levels for each item are summarised in Appendix A.

The sound power levels and ultimate predicted noise levels will depend on the number of plant items operating at any one time and their precise location relative to a sensitive receiver. In practice, the predicted levels will vary due to plant moving around the site and not operating intensively or concurrently for a 15 minute assessment period. Shielding and reflection provided by buildings will also vary as plant moves around the site. Therefore, predicted noise levels are conservative.

3.2 Predicted noise levels

Predicted impact classes for the Evening period are illustrated graphically in Appendix B. Each identified receiver in the study area has been coloured to highlight the predicted level of impact.

Detailed predicted noise levels for each potentially affected receiver are presented Appendix C.

Table 10 presents the worst-case predicted noise level of 79 dB(A) during the works, resulting in 8 receivers classed as highly noise affected.

Table 10 Summary of maximum predicted noise level and highly affected receivers for the Evening period.

Maximum cumulative predicted $L_{Aeq,\ 15\ minute}$ noise level	79 dB(A)
Number of highly noise affected receivers (>75 dB)	8

With reference to the CNVS, the number of senstive receivers classified in each impact class for each assessment period are summarised in the following tables.

Table 11 Summary of NML exceedance ranges for standard hours.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	27
Clearly Audible	10 <= 20 dB above NML	0
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 12 Summary of NML exceedance ranges for outside standard hours - weekend.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	27
Clearly Audible	10 <= 20 dB above NML	0
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 13 Summary of NML exceedance ranges for outside standard hours - evenings.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	27
Clearly Audible	10 <= 20 dB above NML	0

Impact class	Predicted noise level	Predicted number of receivers
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 14 Summary of NML exceedance ranges for outside standard hours - nights.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	27
Clearly Audible	10 <= 20 dB above NML	0
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

In the event works are planned for more than two consecutive nights, sleep disturbance has been considered. Table 15 summarises the number of residents predicted to exceed the sleep disturbance screening criterion. Further analysis is also provided to indicate the number of receivers expected to be woken, at LAmax noise levels greater than 65 dBA.

Where exceedances of the awakening criteria are predicted, additional care should be taken, and mitigation measures implemented in line with the CNVS.

Table 15 Summary of predicted exceedances of sleep disturbance screening criterion and awakening criterion.

Criterion	Predicted number of receivers
Potentially Sleep Disturbed (exceed RBL + 15 screening criterion)	0
Exceed 65 dBA awakening criterion	0

3.3 Vibration

The CNVS requires attended vibration measurements at commencement of vibration generating activities to confirm vibration levels satisfy the criteria for that activity.

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. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

Based on the proposed work locations and selected equipment, indicative exceedances of the vibration criteria are summarised in Table 16. The exceedances are based on recommended minimum working distances from vibration intensive plant given in Appendix D of the Construction Noise and Vibration Strategy (Transport for NSW 2019). Vibration impacts for each sensitive receiver are listed in Appendix C.

Table 16 Predicted exceedances of vibration criteria

Impact classification	Number of potentially affected receivers
Human comfort	28
Cosmetic damage	0
Heritage structure	0

4 Controls and safeguards

The Project represents a risk of adverse impacts on sensitive receivers, particularly when working close to the project boundary and outside approved hours.

Where short term noise impacts are unavoidable, mitigation measures described in the project construction environment management plan should be implemented together with the recommendations in in Table 14.

Table 17 and additional mitigation measures for each receiver identified in Appendix B and summarised in Table 14.

Table 17 Standard mitigation measures

Community consultation	• Potentially affected receivers will be notified of OOH works in accordance with project requirements. • Where practicable, works will be scheduled to not conflict with major student examination periods, church congregation times, and other sensitive periods identified through community consultation.
Site induction	• All workers will be inducted to the project prior to commencing work and will be cognisant of their noise and vibration obligations under the CNVMP.
Behavioural practices	• Avoid swearing and unnecessary shouting or loud radios onsite. • Avoid dropping materials from height.
Equipment selection	• Priority given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable. • The noise levels of plant and equipment would meet the maximum noise requirements of the CNVS.
Use and siting of plant	• Locate compounds away from sensitive receivers and discourage access from local roads. • Plant used intermittently to be throttled down or shut down. • Noise-emitting plant to be directed away from sensitive receivers where possible. • Stationary plant should be located behind a structure or enclosed if practicable. • Deliveries should be made as far as practical from sensitive receivers. Dedicated loading/unloading sites should be shielded where possible, if close to receivers. • Plan traffic flow, parking and loading/unloading areas to minimise reversing. • Avoid compression breaking on approach to the site. • Where additional activities or plant may result in marginal noise increases and speed works up, consider concentrating activities at one location and complete works as quickly as possible.
Non-tonal reversing alarms.	• Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Noise monitoring	• Monitoring should be completed to verify the assumptions of this CNVIS regarding estimated equipment noise emissions and to ensure compliance with the CNVS.
Vibration monitoring	• Attended vibration measurements should be completed at commencement of vibration generating activities predicted to occur within safe working distances for cosmetic damage. • Where monitoring demonstrates maximum levels exceeded, consider alternative methodologies/equipment
Implement any project specific mitigation measures	
1	Mitigation mesasures as per Project NVMP & DNVIS.

Table 18 Additional mitigation measures

Code	Measure	Description
AA	Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.
M	Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, 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 receiver have 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 has been exceeded so that additional management measures may be implemented.
IB	Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
LB	Letterbox drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.
RO	Respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.
PC	Phone calls	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Appendix A Proposed activities and associated sound power levels

Section 2 - Stage 3 - Installation of Pipeline & Reinstatement of Surface

Installation of pipeline, backfill excavations, compact and reinstate surface with asphalt.

12/06/2023 8:00:09 PM - 17/06/2023 5:00:21 AM

Equipment	Quantity	Usage	Reduction	SWL
Bogies	1	30 %	0	95
Plate compactor (small e.g. 60kg)	1	30 %	0	99
Tipper Truck	1	30 %	0	93
Daymakers / Lighting plant	1	100 %	0	93
Light vehicle	1	10 %	0	75

Activity Sound Power Level: 102

* includes 5 dB penalty for potentially annoying characteristics in line with the ICNG

Appendix B Map showing predicted noise impacts by impact class

Appendix C Detailed predictions

C.1 Noise

Assessment: George St Water Discharge Route					NML, LAeq, 15 minute				Sleep, LAmax		Predicted noise level, dBA		Exceedance summary										
														Exceed NML by (dB):				Exceed sleep disturbance by (dB):		Impact classification			
NCA	Rec	Address	Flr	Land use	Day	O/day	Eve	Night	Screen	Awake	Cumulative LAeq, 15 minute	LMax	Highly Affected?	Day	O/day	Eve	Night	Screen	Awake	Day	O/day	Eve	Night
NCA03	747067	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747066	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	747065	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	747064	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			75	83	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	747063	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			76	83	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746885	"1 BARRACK LANE, PARRAMATTA"	4	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746884	"1 BARRACK LANE, PARRAMATTA"	3	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746883	"1 BARRACK LANE, PARRAMATTA"	2	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746882	"1 BARRACK LANE, PARRAMATTA"	1	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745117	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	2	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745116	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	1	COM	70	70	70	70			75	83	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745111	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	5	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745110	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	4	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745109	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	3	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745060	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	5	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745059	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	4	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745058	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	3	COM	70	70	70	70			75	82		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745057	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	2	COM	70	70	70	70			77	84	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745056	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	1	COM	70	70	70	70			78	86	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	744882	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744881	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744880	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			75	82		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	744879	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			77	84	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	744878	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			79	86	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	744541	"94 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744540	"94 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			75	82		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	744539	"94 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			75	83	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable

C.2 Vibration

NCA	Receiver	Address	Land use	Vibration Impact
NCA03	747067	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	COM	Human Comfort

NCA	Receiver	Address	Land use	Vibration Impact
NCA03	747066	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	747065	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	747064	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	747063	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746886	"1 BARRACK LANE, PARRAMATTA"	COM	Human Comfort
NCA03	746885	"1 BARRACK LANE, PARRAMATTA"	COM	Human Comfort
NCA03	746884	"1 BARRACK LANE, PARRAMATTA"	COM	Human Comfort
NCA03	746883	"1 BARRACK LANE, PARRAMATTA"	COM	Human Comfort
NCA03	746882	"1 BARRACK LANE, PARRAMATTA"	COM	Human Comfort
NCA03	745117	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	COM	Human Comfort
NCA03	745116	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	COM	Human Comfort
NCA03	745111	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	COM	Human Comfort
NCA03	745110	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	COM	Human Comfort
NCA03	745109	COOPER & LYBRAND HOUSE SE 2 75 GEORGE ST	COM	Human Comfort
NCA03	745060	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	COM	Human Comfort
NCA03	745059	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	COM	Human Comfort
NCA03	745058	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	COM	Human Comfort
NCA03	745057	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	COM	Human Comfort
NCA03	745056	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	COM	Human Comfort
NCA03	744882	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744881	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744880	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744879	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744878	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744541	"94 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744540	"94 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744539	"94 GEORGE ST, PARRAMATTA"	COM	Human Comfort

GAMUDA Australia

LAING O'ROURKE

Construction noise and vibration impact statement

George St Water Discharge Route

Project	SMW WTP - Westmead and Parramatta		
Client	Gamuda Laing O'Rourke Consortium		
Assessment Date	02/03/2023	Assessment Id	PARRA-036
Proposed start date	19/06/2023	Proposed end date	23/06/2023

Contents

Acoustic terms and acronyms

AA	Acoustic Advisor
AMM	Additional mitigation measures – applicable where standard measures have been implemented and NML is still expected to be exceeded.
dB(A)	Unit used to measure ‘A-weighted’ sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
ICNG	Interim Construction Noise Guideline (Department of Environment and Climate Change 2009)
NCA	Noise Catchment Area
Noise level statistics	L_{A90} - The A-weighted sound pressure level exceeded 90% of the monitoring period. This is considered to represent the background noise. L_{Aeq} - The equivalent continuous A-weighted noise level—the level of noise equivalent to the energy average of noise levels occurring over a measurement period. L_{A1} – The A-weighted sound pressure level exceeded 1% of the monitoring period. L_{Amax} – The maximum A-weighted noise level associated with the measurement period.
NML	Noise Management Level
PPV	Peak Particle Velocity – Measurement of ground-borne vibration in units of mm/s
RBL	Rating Background Level - a single figure that represents the background noise level for assessment purposes
ROL	Road Occupancy Licence – granted by Transport for NSW and required for any activity likely to impact on traffic flow.
SWL	Sound Power Level - The A-weighted sound power level is a logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
SPL	Sound pressure level - This is the level of noise, usually expressed in dB(A), as measured by a standard sound level meter with a pressure microphone. The sound pressure level in dB(A) gives a close indication of the subjective loudness of noise. A technical definition for the sound pressure level, in decibels, is 20 times the logarithm (base 10) of the ratio of any two quantities related to a given sound pressure to a reference pressure (typically 20 µPa equivalent to 0 dB).
Tonal noise	Noise with perceptible and definite pitch or tone
VDV	Vibration dose value – used when assessing intermittent vibration as it is sensitive to peaks in vibration acceleration and accumulates the vibration energy received over the daytime and night-time periods

1 Introduction

1.1 Overview

The Sydney Metro Western Tunnelling Package is being delivered by the Gamuda Australia and Laing O'Rourke Consortium (GLC) and includes twin nine-kilometre tunnels between Sydney Olympic Park and Westmead, excavation of two new metro stations, and a stabling and maintenance facility at Clyde (the Project).

During the Project, there is potential for nearby sensitive receivers to experience adverse impacts relating to noise and vibration. The project's Noise and Vibration Management Sub Plan (NVMP) was developed to satisfy the project's Conditions of Approval (CoA) and addresses the assessment and management of noise and vibration impacts during construction.

Under the NVMP, KNOWnoise™, a project-specific noise prediction tool, has been developed to prepare a Construction noise and vibration impact statement (CNIS) for site and activity-specific noise works and provide ongoing risk analysis during project delivery and for when out-of-hours work is proposed (as per the Project's out-of-hours protocol).

This CNIS has been prepared using KNOWnoise™ and addresses activities for construction of the Westmead and Parramatta station boxes and utilities corridor between the two sites, as illustrated in Figure 1.

The structure of this CNIS includes:

- Section 1.2 – Construction works and hours with justification for these works in Section 1.3
- Section 2 – Existing environment
- Section 3 – Assessment framework including noise and vibration management levels
- Section 4 – Construction noise assessment
- Section 5 – Mitigation and management, including consultation

1.2 Planned works

GLC plans to carry out the works described in Appendix A, which lists each assessed activity, its timing and proposed equipment.

1.3 Justification of the works

In line with the Interim Construction Noise Guidelines (DECC 2009), justification is typically required to work outside approved construction hours. These situations may involve low impact or emergency works and works under an out-of-hours work protocol.

GLC proposes the works subject to this assessment outside approved construction hours for the following reason.

- Works are required to be completed outside of standard construction hours as (a) the applicable council permits and Road Occupancy License (ROL) for access to the footpaths and road network will only be issued for non-peak periods (i.e. weekend, evening and night works) along Smith Street; and (b) works are required to be completed without obstructing access to the public and adjacent commercial premises).

Figure 1 Location map

1 Existing environment

1.1 Sensitive receivers

The Westmead study area is centred on the Westmead metro station construction site. The construction site is located to the south of the existing Westmead Station and is bound by Hawkesbury Road to the west, Hassall Street to the east and Baily Street to the south.

Existing noise levels in this study area are generally controlled by transportation noise from the surrounding road network and existing rail line. The area surrounding the construction site is generally suburban and the nearest receivers are residential.

The Parramatta study area is centred on the Parramatta metro station construction site. The construction site is located between George Street and Macquarie Street, and between Church Street and Smith Street.

Existing noise levels in this study area are controlled by road traffic noise and general urban hum associated with the CBD. As with any CBD, existing noise levels and are relatively high during the daytime, evening and night-time. The area surrounding the construction site is mainly commercial and the nearest receivers are close to the boundary of the site. The nearest receivers are typically of general office or retail use.

1.2 Noise catchment areas

To facilitate the assessment of noise impacts from the project and to apply representative Noise Management Levels (NMLs) to all receivers, receivers adjacent to the Westmead and Parramatta sites have been divided into Noise Catchment Areas (NCAs). The Westmead site contains two noise catchments (NCA01 and NCA02) and NCA03 comprises the Parramatta CBD.

NCAs group individual sensitive receivers by representative traits such as existing noise environment and potential exposure to noise and vibration from the Project.

NCAs established as part of the EIS are summarised in Table 1 and illustrated in Figure 1. Background noise monitoring has been completed as part of the EIS to apply appropriate NML to each NCA.

Table 1 Summary of work areas, Noise Catchment Areas and land uses

NCA	Location	Description
1	Westmead	North of the existing rail corridor in Westmead and mainly residential. 'Other sensitive' receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.
2		South of the existing rail corridor and mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.
3	Parramatta	Covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many 'other sensitive' receivers in this catchment, including Western Sydney University, Arthur Phillip High School, Parramatta Public School, and a number of hotels and places of worship.

2 Assessment framework

2.1 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2. Use of power saws, rock breakers, drills and other tonal or impulsive activities are defined as annoying under the Interim Construction Noise Guideline (ICNG) and are 'highly noise intensive works'.

Table 2 Approved construction hours

CoA	Construction activity	Monday to Friday	Saturday	Sunday / Public holiday
D35	Approved construction	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work (unless approved under EPL or out-of-hours work protocol)
D36	Highly noise intensive works	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work (unless approved under EPL or out-of-hours work protocol)

Notes:

1. if continuously, then not exceeding three hours, with a minimum cessation of work of not less than one hour.

2.2 Noise assessment criteria

2.2.1 Construction noise

The ICNG describes noise in excess of the background level as potentially having an adverse impact on sensitive receivers and increasing the likelihood of complaint. During standard construction hours, where construction noise is within 10 dB(A) of the RBL, impacts would be acceptable.

Where construction noise is more than 10 dB(A) above the RBL during standard construction hours, a residential receiver is considered noise affected and the proponent should undertake all reasonable and feasible steps necessary to manage the impact and consult with the affected community.

Above a $L_{Aeq,\ 15\ minute}$ noise level of 75 dB(A), a receiver is highly affected, requiring consideration of additional mitigation measures including alternative accommodation in the night period.

Outside standard construction hours, construction noise at a residential receiver more than 5 dB(A) above the RBL is taken to be noise affected. Table 1 (reproduced from Table 2 of the ICNG) sets out the NMLs for residences and how they are to be applied.

In addition, annoying noise such as rock hammers, impact piling, or other impulsive noise sources usually result in greater annoyance than continuous construction noise. A 5 dB(A) penalty is applicable to such activities prior to comparison with the NMLs.

2.2.2 Sleep disturbance

The CNVS requires maximum noise levels to be analysed in terms of the extent and number of times the maximum noise exceeds specific noise trigger levels, in general accordance with the Noise Policy for Industry (NPfI) (EPA 2017). These triggers are:

- LAeq, 15 minute 40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and the
- LAmax 52 dBA or the prevailing RBL plus 15 dB, whichever is greater.

The NPfI also recommends the DECCW (2011) Road Noise Policy (RNP) be reviewed for further risk assessment. The RNP recommends maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep and one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

Table 3 Residential noise management levels

Time of day	NML $L_{Aeq\ (15\ min)}$ *	How to apply
Standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Other sensitive land uses, such as schools and offices, typically find noise from construction disruptive when the properties are being used (such as during work and school times). The noise management levels for non-residential receivers set in accordance with the Interim Construction Noise Guideline are provided in Table 4. These levels apply only during hours when the non-residential premises are being used.

The difference between an internal noise level and the external noise level is about 10 dB(A), which provides a conservative assumption that windows are open for ventilation. Buildings where windows are fixed or cannot otherwise be opened may achieve a greater noise level performance.

Table 4 Non-residential sensitive land uses noise management levels

Land use	Noise assessment location	NML ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Places of worship		
Active recreation areas (such as sporting activities and activities which generate their own noise or focus for participants)	External	65
Passive recreation areas (contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External	60
Industrial premises	External	75
Office, retail outlets	External	70

2.3 Project construction noise management levels

The Project specific construction noise management levels for residential receivers have been established in line with the ICNG, based on the RBLs relevant to each NCA. These are presented in Table 5. NMLs for non-residential sensitive receivers are described in Table 4.

Table 5 Project specific construction NMLs

NCA	Noise Management Level, $L_{Aeq\ 15\ minute}$						
	Approved hours		Outside approved hours				
	Noise affected	Highly noise affected	Day	Evening	Night	Sleep disturbance (CNVS) $L_{Aeq,\ 15\ minute}$	Sleep disturbance (CNVS) L_{Amax}
1	58	75	53	51	46	46	56
2	59	75	54	52	42	42	52
3	68	75	63	58	48	48	58

As part of planning for out of hours works, standard mitigation measures, as described in the CNVMP, are implemented where reasonable and feasible. However, after these measures have been applied, noise and vibration levels may continue to exceed the NMLs.

In this case, additional mitigation measures outlined in the CNVS, which largely focus on engagement with affected sensitive receivers, should be implemented where reasonable and feasible, unless other agreements are in place with the impacted receiver.

Triggers and additional mitigation measures for airborne noise are taken from the Project's OOHW Protocol and summarised in Table 6. Further details of specific additional mitigation measures are described in the CNVS.

Table 6 Triggers for additional mitigation measures – Airborne noise (Sydney Metro 2020)

Construction hours	Class	dB above NML	Additional management measures
Approved hours Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	N	0 to 10	-
	CA	10 to 20	LB
	MI	20 to 30	LB, M, SN
	HI	>30	LB, M, SN
Evening Monday – Friday: 6pm – 10pm Saturday: 7am – 8am, 6pm – 10pm Sunday / PH: 8am – 6pm	N	0 to 10	LB
	CA	10 to 20	LB, M
	MI	20 to 30	LB, M, SN, RO
	HI	> 30	LB, M, SN, IB, PC, RO
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am) Sunday / PH: 6pm –7am	N	0 to 10	LB
	CA	10 to 20	LB, M, SN, RO
	MI	20 to 30	LB, M, SN, IB, PC, RO, AA
	HI	> 30	LB, M, SN, IB, PC, RO, AA

Notes: PC = Phone Calls and emails; M = Monitoring; IB = Individual briefings; AA = Alternative accommodation; SN = Specific notification; LB = Letterbox drops; RO = Project specific respite offer

N = Noticeable CA = Clearly audible MI Moderately intrusive HI = Highly intrusive

2.4 Vibration management

2.4.1 Human comfort

When assessing human exposure to construction-related vibration, the CNVS requires vibration goals to be established using *Environmental Noise Management Assessing Vibration: A Technical Guideline* (DECC 2006), which provides criteria for the assessment of vibration impacts on humans.

Construction activities typically generate vibration of an intermittent nature, which is assessed using a Vibration Dose Value (VDV). Acceptable values of vibration doses are presented in Table 7 for sensitive receivers.

Table 7 VDV Vibration criteria

Receiver type	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings – 16 hour day (7am to 11pm)[1]	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings – 8 hour night (11pm to 7am)[1]	0.13	0.26	0.51

Note 1: Day time and night time as described in BS6472:1992 (as referenced in the CNVS), i.e. a daytime period of 16 h or a night time period of 8 h, for example 23.00 h to 07.00 h.

2.4.2 Buildings

Potential building damage from construction vibration requires the application of values in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings* Part 2. These values are presented in Table 8 and relate to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Table 8 Guideline values for vibration velocity for the effects of short-term vibration on structures (BS 7385).

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz to 50 mm/s at 40 Hz and above

Where vibration may give rise to magnification due to resonance, especially at lower frequencies where lower guide values apply, the guide values may be reduced by 50%. The CNVS describes rock breaking/hammering and sheet piling activities as having potential to cause dynamic loading in some structures (e.g. residences).

For activity involving rock breakers, piling rigs, vibratory rollers, excavators, vibration predominantly occurs at frequencies in the 10 Hz to 100 Hz range. On this basis, a conservative vibration damage screening level is:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

2.4.3 Heritage

Heritage buildings and structures would be assessed under a conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150). Where vibration levels at heritage items are identified as exceeding this screening level, structural assessment would be completed by the Project team to confirm the structure's sensitivity to vibration. If a heritage building or structure is found to be structurally unsound (following inspection) the conservative criterion would stand. Where the structure is suitably sound, the guideline values from Table 8 would be applicable.

2.4.4 Additional mitigation measures

The CNVS recommends additional mitigation measures where all standard mitigation measures to minimise vibration at the nearest receivers have been implemented and vibration is still predicted to exceed the maximum guideline values. The Additional Mitigation Measures Matrix (AMMM) for vibration from the CNVS is presented in Table 9.

Table 9 Additional Vibration Mitigation Measures (CNVS)

Construction hours	Mitigation measures where predicted vibration levels exceed maximum levels
Approved hours Monday – Friday: 7am – 6pm, Saturday: 8am to 6pm	LB, M, RO
Evening Monday – Friday: 6pm – 10pm; Saturday: 7am – 8am, 6pm – 10pm; Sunday / PH: 8am – 6pm	LB, M, IB, PC, RO, SN
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am); Sunday / PH: 6pm –7am	LB, M, IB, PC, RO, SN, AA

3 Impact assessment

3.1 Modelling method

Predictions of noise impacts were performed using KNOWnoise™, a project-specific noise assessment tool developed by Hutchison Weller for the CTP Project. KNOWnoise calculates the maximum $L_{Aeq,15minute}$ noise level for each identified receiver for each proposed activity using predictions from SoundPlan noise modelling software. Predictions include geometric spreading, air and ground absorptions as well as topographical and structural screening and reflection.

The following components were incorporated in the model:

- Topography – Based on terrain data of 1 m resolution.
- Individual sensitive receivers – Worst-affected façade of each building to 700 metres from the works
- Construction noise sources –Activities and equipment provided by GLC were included in the noise model as individual sources across the nominated work areas for each activity. The maximum predicted LAeq noise level within each work area was identified for each receiver.
- Cumulative impacts – all activities with overlapping time periods are included in cumulative results
- Source height – construction noise sources assumed to be at 1.5 metres above ground level.
- Ground Absorption – Ground assumed to be mixed hard and soft with absorption factor of 0.5
- Meteorology –worst-case meteorological conditions (gentle breeze from source to receiver and stable conditions).
- Residential building structures are included in the model, meaning screening provided by neighboring houses is considered.
- Results are shown for all floors of assessed buildings with the worst-case façade result assumed for the whole floor.

Equipment proposed to be used for OOHW activities together with estimated sound power levels for each item are summarised in Appendix A.

The sound power levels and ultimate predicted noise levels will depend on the number of plant items operating at any one time and their precise location relative to a sensitive receiver. In practice, the predicted levels will vary due to plant moving around the site and not operating intensively or concurrently for a 15 minute assessment period. Shielding and reflection provided by buildings will also vary as plant moves around the site. Therefore, predicted noise levels are conservative.

3.2 Predicted noise levels

Predicted impact classes for the Evening period are illustrated graphically in Appendix B. Each identified receiver in the study area has been coloured to highlight the predicted level of impact.

Detailed predicted noise levels for each potentially affected receiver are presented Appendix C.

Table 10 presents the worst-case predicted noise level of 89 dB(A) during the works, resulting in 55 receivers classed as highly noise affected.

Table 10 Summary of maximum predicted noise level and highly affected receivers for the Evening period.

Maximum cumulative predicted $L_{Aeq,\ 15\ minute}$ noise level	89 dB(A)
Number of highly noise affected receivers (>75 dB)	55

With reference to the CNVS, the number of senstive receivers classified in each impact class for each assessment period are summarised in the following tables.

Table 11 Summary of NML exceedance ranges for standard hours.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	121
Clearly Audible	10 <= 20 dB above NML	26
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 12 Summary of NML exceedance ranges for outside standard hours - weekend.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	129
Clearly Audible	10 <= 20 dB above NML	26
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 13 Summary of NML exceedance ranges for outside standard hours - evenings.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	143
Clearly Audible	10 <= 20 dB above NML	26

Impact class	Predicted noise level	Predicted number of receivers
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 14 Summary of NML exceedance ranges for outside standard hours - nights.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	198
Clearly Audible	10 <= 20 dB above NML	48
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

In the event works are planned for more than two consecutive nights, sleep disturbance has been considered. Table 15 summarises the number of residents predicted to exceed the sleep disturbance screening criterion. Further analysis is also provided to indicate the number of receivers expected to be woken, at LAmax noise levels greater than 65 dBA.

Where exceedances of the awakening criteria are predicted, additional care should be taken, and mitigation measures implemented in line with the CNVS.

Table 15 Summary of predicted exceedances of sleep disturbance screening criterion and awakening criterion.

Criterion	Predicted number of receivers
Potentially Sleep Disturbed (exceed RBL + 15 screening criterion)	0
Exceed 65 dBA awakening criterion	0

3.3 Vibration

The CNVS requires attended vibration measurements at commencement of vibration generating activities to confirm vibration levels satisfy the criteria for that activity.

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. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

Based on the proposed work locations and selected equipment, indicative exceedances of the vibration criteria are summarised in Table 16. The exceedances are based on recommended minimum working distances from vibration intensive plant given in Appendix D of the Construction Noise and Vibration Strategy (Transport for NSW 2019). Vibration impacts for each sensitive receiver are listed in Appendix C.

Table 16 Predicted exceedances of vibration criteria

Impact classification	Number of potentially affected receivers
Human comfort	0
Cosmetic damage	0
Heritage structure	0

4 Controls and safeguards

The Project represents a risk of adverse impacts on sensitive receivers, particularly when working close to the project boundary and outside approved hours.

Where short term noise impacts are unavoidable, mitigation measures described in the project construction environment management plan should be implemented together with the recommendations in in Table 14.

Table 17 and additional mitigation measures for each receiver identified in Appendix B and summarised in Table 14.

Table 17 Standard mitigation measures

Community consultation	• Potentially affected receivers will be notified of OOH works in accordance with project requirements. • Where practicable, works will be scheduled to not conflict with major student examination periods, church congregation times, and other sensitive periods identified through community consultation.
Site induction	• All workers will be inducted to the project prior to commencing work and will be cognisant of their noise and vibration obligations under the CNVMP.
Behavioural practices	• Avoid swearing and unnecessary shouting or loud radios onsite. • Avoid dropping materials from height.
Equipment selection	• Priority given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable. • The noise levels of plant and equipment would meet the maximum noise requirements of the CNVS.
Use and siting of plant	• Locate compounds away from sensitive receivers and discourage access from local roads. • Plant used intermittently to be throttled down or shut down. • Noise-emitting plant to be directed away from sensitive receivers where possible. • Stationary plant should be located behind a structure or enclosed if practicable. • Deliveries should be made as far as practical from sensitive receivers. Dedicated loading/unloading sites should be shielded where possible, if close to receivers. • Plan traffic flow, parking and loading/unloading areas to minimise reversing. • Avoid compression breaking on approach to the site. • Where additional activities or plant may result in marginal noise increases and speed works up, consider concentrating activities at one location and complete works as quickly as possible.
Non-tonal reversing alarms.	• Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Noise monitoring	• Monitoring should be completed to verify the assumptions of this CNVIS regarding estimated equipment noise emissions and to ensure compliance with the CNVS.
Vibration monitoring	• Attended vibration measurements should be completed at commencement of vibration generating activities predicted to occur within safe working distances for cosmetic damage. • Where monitoring demonstrates maximum levels exceeded, consider alternative methodologies/equipment
Implement any project specific mitigation measures	
1	Mitigation mesasures as per Project NVMP & DNVIS.

Table 18 Additional mitigation measures

Code	Measure	Description
AA	Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.
M	Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, 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 receiver have 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 has been exceeded so that additional management measures may be implemented.
IB	Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
LB	Letterbox drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.
RO	Respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.
PC	Phone calls	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Appendix A Proposed activities and associated sound power levels

Section 3 - Stage 1 - Saw Cutting Pavement

Pipeline located below ground. Saw cutting will be required for the removal of the footpath and roadway pavement.
19/06/2023 8:00:08 PM - 23/06/2023 10:00:20 PM

Equipment	Quantity	Usage	Reduction	SWL
Concrete Saw (Std)*	1	30 %	3	111
Daymakers / Lighting plant	1	100 %	0	93
Light vehicle	1	10 %	0	75

Activity Sound Power Level: 111

* includes 5 dB penalty for potentially annoying characteristics in line with the ICNG

Appendix B Map showing predicted noise impacts by impact class

Appendix C Detailed predictions

C.1 Noise

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Construction noise impact statement

Assessment: George St Water Discharge Route					NML, LAeq, 15 minute				Sleep, LAmax		Predicted noise level, dBA		Exceedance summary										
														Exceed NML by (dB):				Exceed sleep disturbance by (dB):		Impact classification			
NCA	Rec	Address	Flr	Land use	Day	O/day	Eve	Night	Screen	Awake	Cumulative LAeq, 15 minute	LMax	Highly Affected?	Day	O/day	Eve	Night	Screen	Awake	Day	O/day	Eve	Night
NCA03	747083	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	21	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747082	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	20	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747081	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	19	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	747080	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	18	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	747079	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	17	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	747078	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	16	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	747077	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	15	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	747076	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	14	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	747075	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	13	COM	70	70	70	70			73	79		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	747074	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	747073	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	747072	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			74	80		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	747071	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			75	80		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	747070	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			75	80		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	747069	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			75	81	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	747068	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	747067	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	747066	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	747065	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			76	82	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	747064	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			76	82	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	747063	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			75	80		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746886	"1 BARRACK LANE, PARRAMATTA"	5	COM	70	70	70	70			80	86	Y	10	10	10	10	-	10	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746885	"1 BARRACK LANE, PARRAMATTA"	4	COM	70	70	70	70			82	87	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746884	"1 BARRACK LANE, PARRAMATTA"	3	COM	70	70	70	70			84	90	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746883	"1 BARRACK LANE, PARRAMATTA"	2	COM	70	70	70	70			87	92	Y	17	17	17	17	-	17	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746882	"1 BARRACK LANE, PARRAMATTA"	1	COM	70	70	70	70			89	94	Y	19	19	19	19	-	19	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746692	"91 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746691	"91 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746690	"91 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			77	83	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746689	"91 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746688	"91 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			79	84	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746687	"91 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			80	85	Y	10	10	10	10	-	10	Noticable	Noticable	Noticable	Noticable
NCA03	746686	"91 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			81	86	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible

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NCA03	746685	"91 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			82	87	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746684	"91 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			83	88	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746683	"91 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			83	88	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746498	"LEVEL 1 107 PHILLIP ST, PARRAMATTA"	7	COM	65	65	65	65			66	71		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746170	"150 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			70	76		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	746169	"150 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746168	"150 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746167	"150 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746166	"150 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746165	"150 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			71	77		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746164	"150 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746163	"150 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746162	"150 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746161	"150 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746160	"150 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746159	"150 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746113	"140 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			79	85	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746047	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746046	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746045	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			75	80		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746044	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			75	80	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746043	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746042	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746041	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746040	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			79	84	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746039	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			81	86	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746038	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			82	88	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746037	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			84	89	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746036	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			85	91	Y	15	15	15	15	-	15	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746011	"95-101 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			70	75		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	746010	"95-101 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746009	"95-101 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746008	"95-101 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746007	"95-101 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			71	77		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746006	"95-101 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746005	"95-101 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable

NCA03	746004	"95-101 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746003	"95-101 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746002	"95-101 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745800	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	18	EDU	55	55	55	55			64	69		9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	745799	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	17	EDU	55	55	55	55			63	69		8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	745798	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	16	EDU	55	55	55	55			63	68		8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	745797	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	15	EDU	55	55	55	55			63	68		8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	745796	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	14	EDU	55	55	55	55			62	68		7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745795	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	13	EDU	55	55	55	55			62	68		7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745794	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	12	EDU	55	55	55	55			62	67		7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745793	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	11	EDU	55	55	55	55			61	66		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745792	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	10	EDU	55	55	55	55			61	66		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745791	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	9	EDU	55	55	55	55			60	65		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745790	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	8	EDU	55	55	55	55			60	65		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745789	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	7	EDU	55	55	55	55			59	65		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745788	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	6	EDU	55	55	55	55			59	64		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745787	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	5	EDU	55	55	55	55			59	64		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745786	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	4	EDU	55	55	55	55			58	63		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745785	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	3	EDU	55	55	55	55			58	63		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745784	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	2	EDU	55	55	55	55			57	62		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745632	"85 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			84	89	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745596	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745595	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			75	80		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745594	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			75	81	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745593	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745592	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	745591	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			79	84	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	745590	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			80	86	Y	10	10	10	10	-	10	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745589	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			82	87	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745588	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			84	89	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745587	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			85	90	Y	15	15	15	15	-	15	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745466	"130 GEORGE ST, PARRAMATTA"	13	COM	70	70	70	70			70	75		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745465	"130 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			70	76		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745464	"130 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745463	"130 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745462	"130 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable

NCA03	745461	"130 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745460	"130 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745459	"130 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745458	"130 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745457	"130 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745456	"130 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745455	"130 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745454	"130 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745278	"85 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			70	76		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745277	"85 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745276	"85 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			70	76		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745275	"85 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			70	76		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745274	"85 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745273	"85 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745272	"85 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745271	"85 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745064	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	9	COM	70	70	70	70			70	76		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745063	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	8	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745062	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	7	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745061	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	6	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745060	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	5	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745059	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	4	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745058	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	3	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745057	ANZ BANK OFFICE SE 1 LEVEL 3 20 SMITH ST	2	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744949	"30 CHARLES ST, PARRAMATTA"	11	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	744948	"30 CHARLES ST, PARRAMATTA"	10	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	744947	"30 CHARLES ST, PARRAMATTA"	9	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	744946	"30 CHARLES ST, PARRAMATTA"	8	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	744945	"30 CHARLES ST, PARRAMATTA"	7	RES	68	63	58	48			63	68		0	0	5	15	-	5	None	Noticable	Noticable	Clearly Audible
NCA03	744944	"30 CHARLES ST, PARRAMATTA"	6	RES	68	63	58	48			63	68		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	744943	"30 CHARLES ST, PARRAMATTA"	5	RES	68	63	58	48			62	67		0	0	4	14	-	4	None	None	Noticable	Clearly Audible
NCA03	744942	"30 CHARLES ST, PARRAMATTA"	4	RES	68	63	58	48			62	67		0	0	4	14	-	4	None	None	Noticable	Clearly Audible
NCA03	744941	"30 CHARLES ST, PARRAMATTA"	3	RES	68	63	58	48			61	67		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	744940	"30 CHARLES ST, PARRAMATTA"	2	RES	68	63	58	48			61	66		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	744939	"30 CHARLES ST, PARRAMATTA"	1	RES	68	63	58	48			60	66		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	744938	"30 CHARLES ST, PARRAMATTA"	14	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible

NCA03	744937	"30 CHARLES ST, PARRAMATTA"	13	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	744936	"30 CHARLES ST, PARRAMATTA"	12	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	744901	"22 CHARLES ST, PARRAMATTA"	4	RES	68	63	58	48			59	64		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	744900	"22 CHARLES ST, PARRAMATTA"	3	RES	68	63	58	48			58	63		0	0	0	10	-	0	None	None	Noticable	Clearly Audible
NCA03	744899	"22 CHARLES ST, PARRAMATTA"	10	RES	68	63	58	48			61	66		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	744898	"22 CHARLES ST, PARRAMATTA"	9	RES	68	63	58	48			61	66		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	744897	"22 CHARLES ST, PARRAMATTA"	8	RES	68	63	58	48			60	66		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	744896	"22 CHARLES ST, PARRAMATTA"	7	RES	68	63	58	48			60	65		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	744895	"22 CHARLES ST, PARRAMATTA"	6	RES	68	63	58	48			60	65		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	744894	"22 CHARLES ST, PARRAMATTA"	5	RES	68	63	58	48			59	64		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	744889	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			73	79		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744888	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744887	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			75	80		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	744886	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			75	80	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	744885	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	744884	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	744883	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	744882	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	744881	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			79	84	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	744880	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			80	85	Y	10	10	10	10	-	10	Noticable	Noticable	Noticable	Noticable
NCA03	744879	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			81	86	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744878	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			81	86	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744376	"89 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			84	89	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744375	"89 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			85	90	Y	15	15	15	15	-	15	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744261	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	4	COM	70	70	70	70			82	87	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744260	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	3	COM	70	70	70	70			83	88	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744259	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	2	COM	70	70	70	70			83	89	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744258	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	1	COM	70	70	70	70			84	89	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible

C.2 Vibration

NCA	Receiver	Address	Land use	Vibration Impact

Construction noise and vibration impact statement

George St Water Discharge Route

Project	SMW WTP - Westmead and Parramatta
Client	Gamuda Laing O'Rourke Consortium

Assessment Date	02/03/2023	Assessment Id	PARRA-036
Proposed start date	19/06/2023	Proposed end date	24/06/2023

Contents

Acoustic terms and acronyms

AA	Acoustic Advisor
AMM	Additional mitigation measures – applicable where standard measures have been implemented and NML is still expected to be exceeded.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
ICNG	Interim Construction Noise Guideline (Department of Environment and Climate Change 2009)
NCA	Noise Catchment Area
Noise level statistics	L_{A90} - The A-weighted sound pressure level exceeded 90% of the monitoring period. This is considered to represent the background noise. L_{Aeq} - The equivalent continuous A-weighted noise level—the level of noise equivalent to the energy average of noise levels occurring over a measurement period. L_{A1} – The A-weighted sound pressure level exceeded 1% of the monitoring period. L_{Amax} – The maximum A-weighted noise level associated with the measurement period.
NML	Noise Management Level
PPV	Peak Particle Velocity – Measurement of ground-borne vibration in units of mm/s
RBL	Rating Background Level - a single figure that represents the background noise level for assessment purposes
ROL	Road Occupancy Licence – granted by Transport for NSW and required for any activity likely to impact on traffic flow.
SWL	Sound Power Level - The A-weighted sound power level is a logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
SPL	Sound pressure level - This is the level of noise, usually expressed in dB(A), as measured by a standard sound level meter with a pressure microphone. The sound pressure level in dB(A) gives a close indication of the subjective loudness of noise. A technical definition for the sound pressure level, in decibels, is 20 times the logarithm (base 10) of the ratio of any two quantities related to a given sound pressure to a reference pressure (typically 20 µPa equivalent to 0 dB).
Tonal noise	Noise with perceptible and definite pitch or tone
VDV	Vibration dose value – used when assessing intermittent vibration as it is sensitive to peaks in vibration acceleration and accumulates the vibration energy received over the daytime and night-time periods

1 Introduction

1.1 Overview

The Sydney Metro Western Tunnelling Package is being delivered by the Gamuda Australia and Laing O'Rourke Consortium (GLC) and includes twin nine-kilometre tunnels between Sydney Olympic Park and Westmead, excavation of two new metro stations, and a stabling and maintenance facility at Clyde (the Project).

During the Project, there is potential for nearby sensitive receivers to experience adverse impacts relating to noise and vibration. The project's Noise and Vibration Management Sub Plan (NVMP) was developed to satisfy the project's Conditions of Approval (CoA) and addresses the assessment and management of noise and vibration impacts during construction.

Under the NVMP, KNOWnoise™, a project-specific noise prediction tool, has been developed to prepare a Construction noise and vibration impact statement (CNIS) for site and activity-specific noise works and provide ongoing risk analysis during project delivery and for when out-of-hours work is proposed (as per the Project's out-of-hours protocol).

This CNIS has been prepared using KNOWnoise™ and addresses activities for construction of the Westmead and Parramatta station boxes and utilities corridor between the two sites, as illustrated in Figure 1.

The structure of this CNIS includes:

- Section 1.2 – Construction works and hours with justification for these works in Section 1.3
- Section 2 – Existing environment
- Section 3 – Assessment framework including noise and vibration management levels
- Section 4 – Construction noise assessment
- Section 5 – Mitigation and management, including consultation

1.2 Planned works

GLC plans to carry out the works described in Appendix A, which lists each assessed activity, its timing and proposed equipment.

1.3 Justification of the works

In line with the Interim Construction Noise Guidelines (DECC 2009), justification is typically required to work outside approved construction hours. These situations may involve low impact or emergency works and works under an out-of-hours work protocol.

GLC proposes the works subject to this assessment outside approved construction hours for the following reason.

- Works are required to be completed outside of standard construction hours as (a) the applicable council permits and Road Occupancy License (ROL) for access to the footpaths and road network will only be issued for non-peak periods (i.e. weekend, evening and night works) along Smith Street; and (b) works are required to be completed without obstructing access to the public and adjacent commercial premises).

Figure 1 Location map

1 Existing environment

1.1 Sensitive receivers

The Westmead study area is centred on the Westmead metro station construction site. The construction site is located to the south of the existing Westmead Station and is bound by Hawkesbury Road to the west, Hassall Street to the east and Baily Street to the south.

Existing noise levels in this study area are generally controlled by transportation noise from the surrounding road network and existing rail line. The area surrounding the construction site is generally suburban and the nearest receivers are residential.

The Parramatta study area is centred on the Parramatta metro station construction site. The construction site is located between George Street and Macquarie Street, and between Church Street and Smith Street.

Existing noise levels in this study area are controlled by road traffic noise and general urban hum associated with the CBD. As with any CBD, existing noise levels and are relatively high during the daytime, evening and night-time. The area surrounding the construction site is mainly commercial and the nearest receivers are close to the boundary of the site. The nearest receivers are typically of general office or retail use.

1.2 Noise catchment areas

To facilitate the assessment of noise impacts from the project and to apply representative Noise Management Levels (NMLs) to all receivers, receivers adjacent to the Westmead and Parramatta sites have been divided into Noise Catchment Areas (NCAs). The Westmead site contains two noise catchments (NCA01 and NCA02) and NCA03 comprises the Parramatta CBD.

NCAs group individual sensitive receivers by representative traits such as existing noise environment and potential exposure to noise and vibration from the Project.

NCAs established as part of the EIS are summarised in Table 1 and illustrated in Figure 1. Background noise monitoring has been completed as part of the EIS to apply appropriate NML to each NCA.

Table 1 Summary of work areas, Noise Catchment Areas and land uses

NCA	Location	Description
1	Westmead	North of the existing rail corridor in Westmead and mainly residential. ‘Other sensitive’ receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.
2		South of the existing rail corridor and mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.
3	Parramatta	Covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many ‘other sensitive’ receivers in this catchment, including Western Sydney University, Arthur Phillip High School, Parramatta Public School, and a number of hotels and places of worship.

2 Assessment framework

2.1 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2. Use of power saws, rock breakers, drills and other tonal or impulsive activities are defined as annoying under the Interim Construction Noise Guideline (ICNG) and are 'highly noise intensive works'.

Table 2 Approved construction hours

CoA	Construction activity	Monday to Friday	Saturday	Sunday / Public holiday
D35	Approved construction	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work (unless approved under EPL or out-of-hours work protocol)
D36	Highly noise intensive works	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work (unless approved under EPL or out-of-hours work protocol)

Notes:
1. if continuously, then not exceeding three hours, with a minimum cessation of work of not less than one hour.

2.2 Noise assessment criteria

2.2.1 Construction noise

The ICNG describes noise in excess of the background level as potentially having an adverse impact on sensitive receivers and increasing the likelihood of complaint. During standard construction hours, where construction noise is within 10 dB(A) of the RBL, impacts would be acceptable.

Where construction noise is more than 10 dB(A) above the RBL during standard construction hours, a residential receiver is considered noise affected and the proponent should undertake all reasonable and feasible steps necessary to manage the impact and consult with the affected community.

Above a $L_{Aeq,\ 15\ minute}$ noise level of 75 dB(A), a receiver is highly affected, requiring consideration of additional mitigation measures including alternative accommodation in the night period.

Outside standard construction hours, construction noise at a residential receiver more than 5 dB(A) above the RBL is taken to be noise affected. Table 1 (reproduced from Table 2 of the ICNG) sets out the NMLs for residences and how they are to be applied.

In addition, annoying noise such as rock hammers, impact piling, or other impulsive noise sources usually result in greater annoyance than continuous construction noise. A 5 dB(A) penalty is applicable to such activities prior to comparison with the NMLs.

2.2.2 Sleep disturbance

The CNVS requires maximum noise levels to be analysed in terms of the extent and number of times the maximum noise exceeds specific noise trigger levels, in general accordance with the Noise Policy for Industry (NPfI) (EPA 2017). These triggers are:

- LAeq, 15 minute 40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and the
- LAmax 52 dBA or the prevailing RBL plus 15 dB, whichever is greater.

The NPfI also recommends the DECCW (2011) Road Noise Policy (RNP) be reviewed for further risk assessment. The RNP recommends maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep and one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

Table 3 Residential noise management levels

Time of day	NML $L_{Aeq\ (15\ min)}$ *	How to apply
Standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Other sensitive land uses, such as schools and offices, typically find noise from construction disruptive when the properties are being used (such as during work and school times). The noise management levels for non-residential receivers set in accordance with the Interim Construction Noise Guideline are provided in Table 4. These levels apply only during hours when the non-residential premises are being used.

The difference between an internal noise level and the external noise level is about 10 dB(A), which provides a conservative assumption that windows are open for ventilation. Buildings where windows are fixed or cannot otherwise be opened may achieve a greater noise level performance.

Table 4 Non-residential sensitive land uses noise management levels

Land use	Noise assessment location	NML ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Places of worship		
Active recreation areas (such as sporting activities and activities which generate their own noise or focus for participants)	External	65
Passive recreation areas (contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External	60
Industrial premises	External	75
Office, retail outlets	External	70

2.3 Project construction noise management levels

The Project specific construction noise management levels for residential receivers have been established in line with the ICNG, based on the RBLs relevant to each NCA. These are presented in Table 5. NMLs for non-residential sensitive receivers are described in Table 4.

Table 5 Project specific construction NMLs

NCA	Noise Management Level, $L_{Aeq\ 15\ minute}$						
	Approved hours		Outside approved hours				
	Noise affected	Highly noise affected	Day	Evening	Night	Sleep disturbance (CNVS)	
						$L_{Aeq,\ 15\ minute}$	L_{Amax}
1	58	75	53	51	46	46	56
2	59	75	54	52	42	42	52
3	68	75	63	58	48	48	58

As part of planning for out of hours works, standard mitigation measures, as described in the CNVMP, are implemented where reasonable and feasible. However, after these measures have been applied, noise and vibration levels may continue to exceed the NMLs.

In this case, additional mitigation measures outlined in the CNVS, which largely focus on engagement with affected sensitive receivers, should be implemented where reasonable and feasible, unless other agreements are in place with the impacted receiver.

Triggers and additional mitigation measures for airborne noise are taken from the Project's OOHW Protocol and summarised in Table 6. Further details of specific additional mitigation measures are described in the CNVS.

Table 6 Triggers for additional mitigation measures – Airborne noise (Sydney Metro 2020)

Construction hours	Class	dB above NML	Additional management measures
Approved hours Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	N	0 to 10	-
	CA	10 to 20	LB
	MI	20 to 30	LB, M, SN
	HI	>30	LB, M, SN
Evening Monday – Friday: 6pm – 10pm Saturday: 7am – 8am, 6pm – 10pm Sunday / PH: 8am – 6pm	N	0 to 10	LB
	CA	10 to 20	LB, M
	MI	20 to 30	LB, M, SN, RO
	HI	> 30	LB, M, SN, IB, PC, RO
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am) Sunday / PH: 6pm –7am	N	0 to 10	LB
	CA	10 to 20	LB, M, SN, RO
	MI	20 to 30	LB, M, SN, IB, PC, RO, AA
	HI	> 30	LB, M, SN, IB, PC, RO, AA

Notes: PC = Phone Calls and emails; M = Monitoring; IB = Individual briefings; AA = Alternative accommodation; SN = Specific notification; LB = Letterbox drops; RO = Project specific respite offer

N = Noticeable CA = Clearly audible MI Moderately intrusive HI = Highly intrusive

2.4 Vibration management

2.4.1 Human comfort

When assessing human exposure to construction-related vibration, the CNVS requires vibration goals to be established using *Environmental Noise Management Assessing Vibration: A Technical Guideline* (DECC 2006), which provides criteria for the assessment of vibration impacts on humans.

Construction activities typically generate vibration of an intermittent nature, which is assessed using a Vibration Dose Value (VDV). Acceptable values of vibration doses are presented in Table 7 for sensitive receivers.

Table 7 VDV Vibration criteria

Receiver type	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings – 16 hour day (7am to 11pm)[1]	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings – 8 hour night (11pm to 7am)[1]	0.13	0.26	0.51

Note 1: Day time and night time as described in BS6472:1992 (as referenced in the CNVS), i.e. a daytime period of 16 h or a night time period of 8 h, for example 23.00 h to 07.00 h.

2.4.2 Buildings

Potential building damage from construction vibration requires the application of values in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings* Part 2. These values are presented in Table 8 and relate to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Table 8 Guideline values for vibration velocity for the effects of short-term vibration on structures (BS 7385).

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz to 50 mm/s at 40 Hz and above

Where vibration may give rise to magnification due to resonance, especially at lower frequencies where lower guide values apply, the guide values may be reduced by 50%. The CNVS describes rock breaking/hammering and sheet piling activities as having potential to cause dynamic loading in some structures (e.g. residences).

For activity involving rock breakers, piling rigs, vibratory rollers, excavators, vibration predominantly occurs at frequencies in the 10 Hz to 100 Hz range. On this basis, a conservative vibration damage screening level is:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

2.4.3 Heritage

Heritage buildings and structures would be assessed under a conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150). Where vibration levels at heritage items are identified as exceeding this screening level, structural assessment would be completed by the Project team to confirm the structure's sensitivity to vibration. If a heritage building or structure is found to be structurally unsound (following inspection) the conservative criterion would stand. Where the structure is suitably sound, the guideline values from Table 8 would be applicable.

2.4.4 Additional mitigation measures

The CNVS recommends additional mitigation measures where all standard mitigation measures to minimise vibration at the nearest receivers have been implemented and vibration is still predicted to exceed the maximum guideline values. The Additional Mitigation Measures Matrix (AMMM) for vibration from the CNVS is presented in Table 9.

Table 9 Additional Vibration Mitigation Measures (CNVS)

Construction hours	Mitigation measures where predicted vibration levels exceed maximum levels
Approved hours Monday – Friday: 7am – 6pm, Saturday: 8am to 6pm	LB, M, RO
Evening Monday – Friday: 6pm – 10pm; Saturday: 7am – 8am, 6pm – 10pm; Sunday / PH: 8am – 6pm	LB, M, IB, PC, RO, SN
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am); Sunday / PH: 6pm –7am	LB, M, IB, PC, RO, SN, AA

3 Impact assessment

3.1 Modelling method

Predictions of noise impacts were performed using KNOWnoise™, a project-specific noise assessment tool developed by Hutchison Weller for the CTP Project. KNOWnoise calculates the maximum $L_{Aeq,15minute}$ noise level for each identified receiver for each proposed activity using predictions from SoundPlan noise modelling software. Predictions include geometric spreading, air and ground absorptions as well as topographical and structural screening and reflection.

The following components were incorporated in the model:

- Topography – Based on terrain data of 1 m resolution.
- Individual sensitive receivers – Worst-affected façade of each building to 700 metres from the works
- Construction noise sources –Activities and equipment provided by GLC were included in the noise model as individual sources across the nominated work areas for each activity. The maximum predicted LAeq noise level within each work area was identified for each receiver.
- Cumulative impacts – all activities with overlapping time periods are included in cumulative results
- Source height – construction noise sources assumed to be at 1.5 metres above ground level.
- Ground Absorption – Ground assumed to be mixed hard and soft with absorption factor of 0.5
- Meteorology –worst-case meteorological conditions (gentle breeze from source to receiver and stable conditions).
- Residential building structures are included in the model, meaning screening provided by neighboring houses is considered.
- Results are shown for all floors of assessed buildings with the worst-case façade result assumed for the whole floor.

Equipment proposed to be used for OOHW activities together with estimated sound power levels for each item are summarised in Appendix A.

The sound power levels and ultimate predicted noise levels will depend on the number of plant items operating at any one time and their precise location relative to a sensitive receiver. In practice, the predicted levels will vary due to plant moving around the site and not operating intensively or concurrently for a 15 minute assessment period. Shielding and reflection provided by buildings will also vary as plant moves around the site. Therefore, predicted noise levels are conservative.

3.2 Predicted noise levels

Predicted impact classes for the Evening period are illustrated graphically in Appendix B. Each identified receiver in the study area has been coloured to highlight the predicted level of impact.

Detailed predicted noise levels for each potentially affected receiver are presented Appendix C.

Table 10 presents the worst-case predicted noise level of 87 dB(A) during the works, resulting in 36 receivers classed as highly noise affected.

Table 10 Summary of maximum predicted noise level and highly affected receivers for the Evening period.

Maximum cumulative predicted $L_{Aeq,\ 15\ minute}$ noise level	87 dB(A)
Number of highly noise affected receivers (>75 dB)	36

With reference to the CNVS, the number of senstive receivers classified in each impact class for each assessment period are summarised in the following tables.

Table 11 Summary of NML exceedance ranges for standard hours.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	84
Clearly Audible	10 <= 20 dB above NML	18
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 12 Summary of NML exceedance ranges for outside standard hours - weekend.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	84
Clearly Audible	10 <= 20 dB above NML	18
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 13 Summary of NML exceedance ranges for outside standard hours - evenings.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	103
Clearly Audible	10 <= 20 dB above NML	18

Impact class	Predicted noise level	Predicted number of receivers
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 14 Summary of NML exceedance ranges for outside standard hours - nights.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	129
Clearly Audible	10 <= 20 dB above NML	37
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

In the event works are planned for more than two consecutive nights, sleep disturbance has been considered. Table 15 summarises the number of residents predicted to exceed the sleep disturbance screening criterion. Further analysis is also provided to indicate the number of receivers expected to be woken, at LAmax noise levels greater than 65 dBA.

Where exceedances of the awakening criteria are predicted, additional care should be taken, and mitigation measures implemented in line with the CNVS.

Table 15 Summary of predicted exceedances of sleep disturbance screening criterion and awakening criterion.

Criterion	Predicted number of receivers
Potentially Sleep Disturbed (exceed RBL + 15 screening criterion)	0
Exceed 65 dBA awakening criterion	0

3.3 Vibration

The CNVS requires attended vibration measurements at commencement of vibration generating activities to confirm vibration levels satisfy the criteria for that activity.

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. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

Based on the proposed work locations and selected equipment, indicative exceedances of the vibration criteria are summarised in Table 16. The exceedances are based on recommended minimum working distances from vibration intensive plant given in Appendix D of the Construction Noise and Vibration Strategy (Transport for NSW 2019). Vibration impacts for each sensitive receiver are listed in Appendix C.

Table 16 Predicted exceedances of vibration criteria

Impact classification	Number of potentially affected receivers
Human comfort	0
Cosmetic damage	0
Heritage structure	0

4 Controls and safeguards

The Project represents a risk of adverse impacts on sensitive receivers, particularly when working close to the project boundary and outside approved hours.

Where short term noise impacts are unavoidable, mitigation measures described in the project construction environment management plan should be implemented together with the recommendations in in Table 14.

Table 17 and additional mitigation measures for each receiver identified in Appendix B and summarised in Table 14.

Table 17 Standard mitigation measures

Community consultation	• Potentially affected receivers will be notified of OOH works in accordance with project requirements. • Where practicable, works will be scheduled to not conflict with major student examination periods, church congregation times, and other sensitive periods identified through community consultation.
Site induction	• All workers will be inducted to the project prior to commencing work and will be cognisant of their noise and vibration obligations under the CNVMP.
Behavioural practices	• Avoid swearing and unnecessary shouting or loud radios onsite. • Avoid dropping materials from height.
Equipment selection	• Priority given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable. • The noise levels of plant and equipment would meet the maximum noise requirements of the CNVS.
Use and siting of plant	• Locate compounds away from sensitive receivers and discourage access from local roads. • Plant used intermittently to be throttled down or shut down. • Noise-emitting plant to be directed away from sensitive receivers where possible. • Stationary plant should be located behind a structure or enclosed if practicable. • Deliveries should be made as far as practical from sensitive receivers. Dedicated loading/unloading sites should be shielded where possible, if close to receivers. • Plan traffic flow, parking and loading/unloading areas to minimise reversing. • Avoid compression breaking on approach to the site. • Where additional activities or plant may result in marginal noise increases and speed works up, consider concentrating activities at one location and complete works as quickly as possible.
Non-tonal reversing alarms.	• Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Noise monitoring	• Monitoring should be completed to verify the assumptions of this CNVIS regarding estimated equipment noise emissions and to ensure compliance with the CNVS.
Vibration monitoring	• Attended vibration measurements should be completed at commencement of vibration generating activities predicted to occur within safe working distances for cosmetic damage. • Where monitoring demonstrates maximum levels exceeded, consider alternative methodologies/equipment
Implement any project specific mitigation measures	
1	Mitigation mesasures as per Project NVMP & DNVIS.

Table 18 Additional mitigation measures

Code	Measure	Description
AA	Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.
M	Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, 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 receiver have 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 has been exceeded so that additional management measures may be implemented.
IB	Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
LB	Letterbox drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.
RO	Respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.
PC	Phone calls	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Appendix A Proposed activities and associated sound power levels

Section 3 - Stage 2 - NDD & Pavement Removal

NDD and removal of pavement is required to be lifted to allow for the discharge route piping.
19/06/2023 8:00:37 PM - 24/06/2023 5:00:51 AM

Equipment	Quantity	Usage	Reduction	SWL
Bogies	1	30 %	0	95
Excavator (06 tonne)	1	40 %	0	90
Tipper Truck	1	30 %	0	93
Vacc truck	1	50 %	0	109
Daymakers / Lighting plant	1	100 %	0	93
Light vehicle	1	10 %	0	75

Activity Sound Power Level: 109
* includes 5 dB penalty for potentially annoying characteristics in line with the ICNG

Appendix B Map showing predicted noise impacts by impact class

Appendix C Detailed predictions

C.1 Noise

GAMUDA Australia LAING O'ROURKE

Construction noise impact statement

Assessment: George St Water Discharge Route					NML, LAeq, 15 minute				Sleep, LAmax		Predicted noise level, dBA		Exceedance summary										
														Exceed NML by (dB):				Exceed sleep disturbance by (dB):		Impact classification			
NCA	Rec	Address	Flr	Land use	Day	O/day	Eve	Night	Screen	Awake	Cumulative LAeq, 15 minute	LMax	Highly Affected?	Day	O/day	Eve	Night	Screen	Awake	Day	O/day	Eve	Night
NCA03	747074	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	747073	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	747072	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747071	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747070	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747069	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747068	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747067	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747066	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	747065	"SE 5 GROUND 100 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	746886	"1 BARRACK LANE, PARRAMATTA"	5	COM	70	70	70	70			79	87	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746885	"1 BARRACK LANE, PARRAMATTA"	4	COM	70	70	70	70			81	88	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746884	"1 BARRACK LANE, PARRAMATTA"	3	COM	70	70	70	70			83	91	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746883	"1 BARRACK LANE, PARRAMATTA"	2	COM	70	70	70	70			85	93	Y	15	15	15	15	-	15	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746882	"1 BARRACK LANE, PARRAMATTA"	1	COM	70	70	70	70			87	95	Y	17	17	17	17	-	17	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746692	"91 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746691	"91 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			75	83	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746690	"91 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			76	84	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746689	"91 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			77	84	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746688	"91 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			78	85	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746687	"91 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			79	86	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746686	"91 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			80	87	Y	10	10	10	10	-	10	Noticable	Noticable	Noticable	Noticable
NCA03	746685	"91 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			81	88	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746684	"91 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			81	89	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746683	"91 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			82	89	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746164	"150 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746163	"150 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746162	"150 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746161	"150 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746160	"150 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746113	"140 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			78	86	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746047	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746046	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable

NCA03	746045	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			73	81		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746044	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746043	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746042	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			75	83	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746041	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			76	84	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746040	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			77	84	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746039	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			78	85	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746038	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			79	86	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746037	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			80	87	Y	10	10	10	10	-	10	Noticable	Noticable	Noticable	Noticable
NCA03	746036	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			80	88	Y	10	10	10	10	-	10	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746006	"95-101 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	746005	"95-101 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	746004	"95-101 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746003	"95-101 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745800	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	18	EDU	55	55	55	55			62	70		7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745799	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	17	EDU	55	55	55	55			62	70		7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745798	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	16	EDU	55	55	55	55			62	69		7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745797	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	15	EDU	55	55	55	55			62	69		7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745796	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	14	EDU	55	55	55	55			61	69		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745795	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	13	EDU	55	55	55	55			61	69		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745794	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	12	EDU	55	55	55	55			61	68		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745793	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	11	EDU	55	55	55	55			60	67		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745792	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	10	EDU	55	55	55	55			59	67		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745791	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	9	EDU	55	55	55	55			59	66		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745790	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	8	EDU	55	55	55	55			58	66		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745789	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	7	EDU	55	55	55	55			58	66		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745788	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	6	EDU	55	55	55	55			58	65		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745787	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	5	EDU	55	55	55	55			57	65		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745786	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	4	EDU	55	55	55	55			57	64		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745785	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	3	EDU	55	55	55	55			56	64		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745784	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	2	EDU	55	55	55	55			55	63		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745632	"85 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			82	90	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745596	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745595	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			73	81		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745594	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745593	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			75	83	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable

NCA03	745592	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			76	84	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745591	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			78	85	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	745590	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			79	87	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	745589	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			81	88	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745588	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			82	90	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745587	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			83	91	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745462	"130 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745461	"130 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745460	"130 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745459	"130 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745458	"130 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745457	"130 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745456	"130 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745455	"130 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745454	"130 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744949	"30 CHARLES ST, PARRAMATTA"	11	RES	68	63	58	48			63	70		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	744948	"30 CHARLES ST, PARRAMATTA"	10	RES	68	63	58	48			63	70		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	744947	"30 CHARLES ST, PARRAMATTA"	9	RES	68	63	58	48			63	70		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	744946	"30 CHARLES ST, PARRAMATTA"	8	RES	68	63	58	48			62	70		0	0	4	14	-	4	None	None	Noticable	Clearly Audible
NCA03	744945	"30 CHARLES ST, PARRAMATTA"	7	RES	68	63	58	48			62	69		0	0	4	14	-	4	None	None	Noticable	Clearly Audible
NCA03	744944	"30 CHARLES ST, PARRAMATTA"	6	RES	68	63	58	48			61	69		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	744943	"30 CHARLES ST, PARRAMATTA"	5	RES	68	63	58	48			61	68		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	744942	"30 CHARLES ST, PARRAMATTA"	4	RES	68	63	58	48			60	68		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	744941	"30 CHARLES ST, PARRAMATTA"	3	RES	68	63	58	48			60	68		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	744940	"30 CHARLES ST, PARRAMATTA"	2	RES	68	63	58	48			59	67		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	744939	"30 CHARLES ST, PARRAMATTA"	1	RES	68	63	58	48			59	67		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	744938	"30 CHARLES ST, PARRAMATTA"	14	RES	68	63	58	48			63	70		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	744937	"30 CHARLES ST, PARRAMATTA"	13	RES	68	63	58	48			63	70		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	744936	"30 CHARLES ST, PARRAMATTA"	12	RES	68	63	58	48			63	70		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	744899	"22 CHARLES ST, PARRAMATTA"	10	RES	68	63	58	48			60	67		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	744898	"22 CHARLES ST, PARRAMATTA"	9	RES	68	63	58	48			59	67		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	744897	"22 CHARLES ST, PARRAMATTA"	8	RES	68	63	58	48			59	67		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	744896	"22 CHARLES ST, PARRAMATTA"	7	RES	68	63	58	48			59	66		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	744895	"22 CHARLES ST, PARRAMATTA"	6	RES	68	63	58	48			58	66		0	0	0	10	-	0	None	None	Noticable	Clearly Audible
NCA03	744889	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	744888	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable

NCA03	744887	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744886	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744885	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744884	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744883	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744882	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			73	81		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744881	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			73	81		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744880	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744879	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744878	"LEVEL 9 79 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744376	"89 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			82	90	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744375	"89 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			83	91	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744261	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	4	COM	70	70	70	70			80	88	Y	10	10	10	10	-	10	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744260	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	3	COM	70	70	70	70			81	89	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744259	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	2	COM	70	70	70	70			82	90	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	744258	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	1	COM	70	70	70	70			83	90	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible

C.2 Vibration

NCA	Receiver	Address	Land use	Vibration Impact

Construction noise and vibration impact statement

George St Water Discharge Route

Project	SMW WTP - Westmead and Parramatta		
Client	Gamuda Laing O'Rourke Consortium		
Assessment Date	02/03/2023	Assessment Id	PARRA-036
Proposed start date	19/06/2023	Proposed end date	24/06/2023

Contents

Acoustic terms and acronyms

AA	Acoustic Advisor
AMM	Additional mitigation measures – applicable where standard measures have been implemented and NML is still expected to be exceeded.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
ICNG	Interim Construction Noise Guideline (Department of Environment and Climate Change 2009)
NCA	Noise Catchment Area
Noise level statistics	L_{A90} - The A-weighted sound pressure level exceeded 90% of the monitoring period. This is considered to represent the background noise. L_{Aeq} - The equivalent continuous A-weighted noise level—the level of noise equivalent to the energy average of noise levels occurring over a measurement period. L_{A1} – The A-weighted sound pressure level exceeded 1% of the monitoring period. L_{Amax} – The maximum A-weighted noise level associated with the measurement period.
NML	Noise Management Level
PPV	Peak Particle Velocity – Measurement of ground-borne vibration in units of mm/s
RBL	Rating Background Level - a single figure that represents the background noise level for assessment purposes
ROL	Road Occupancy Licence – granted by Transport for NSW and required for any activity likely to impact on traffic flow.
SWL	Sound Power Level - The A-weighted sound power level is a logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
SPL	Sound pressure level - This is the level of noise, usually expressed in dB(A), as measured by a standard sound level meter with a pressure microphone. The sound pressure level in dB(A) gives a close indication of the subjective loudness of noise. A technical definition for the sound pressure level, in decibels, is 20 times the logarithm (base 10) of the ratio of any two quantities related to a given sound pressure to a reference pressure (typically 20 µPa equivalent to 0 dB).
Tonal noise	Noise with perceptible and definite pitch or tone
VDV	Vibration dose value – used when assessing intermittent vibration as it is sensitive to peaks in vibration acceleration and accumulates the vibration energy received over the daytime and night-time periods

1 Introduction

1.1 Overview

The Sydney Metro Western Tunnelling Package is being delivered by the Gamuda Australia and Laing O'Rourke Consortium (GLC) and includes twin nine-kilometre tunnels between Sydney Olympic Park and Westmead, excavation of two new metro stations, and a stabling and maintenance facility at Clyde (the Project).

During the Project, there is potential for nearby sensitive receivers to experience adverse impacts relating to noise and vibration. The project's Noise and Vibration Management Sub Plan (NVMP) was developed to satisfy the project's Conditions of Approval (CoA) and addresses the assessment and management of noise and vibration impacts during construction.

Under the NVMP, KNOWnoise™, a project-specific noise prediction tool, has been developed to prepare a Construction noise and vibration impact statement (CNIS) for site and activity-specific noise works and provide ongoing risk analysis during project delivery and for when out-of-hours work is proposed (as per the Project's out-of-hours protocol).

This CNIS has been prepared using KNOWnoise™ and addresses activities for construction of the Westmead and Parramatta station boxes and utilities corridor between the two sites, as illustrated in Figure 1.

The structure of this CNIS includes:

- Section 1.2 – Construction works and hours with justification for these works in Section 1.3
- Section 2 – Existing environment
- Section 3 – Assessment framework including noise and vibration management levels
- Section 4 – Construction noise assessment
- Section 5 – Mitigation and management, including consultation

1.2 Planned works

GLC plans to carry out the works described in Appendix A, which lists each assessed activity, its timing and proposed equipment.

1.3 Justification of the works

In line with the Interim Construction Noise Guidelines (DECC 2009), justification is typically required to work outside approved construction hours. These situations may involve low impact or emergency works and works under an out-of-hours work protocol.

GLC proposes the works subject to this assessment outside approved construction hours for the following reason.

- Works are required to be completed outside of standard construction hours as (a) the applicable council permits and Road Occupancy License (ROL) for access to the footpaths and road network will only be issued for non-peak periods (i.e. weekend, evening and night works) along Smith Street; and (b) works are required to be completed without obstructing access to the public and adjacent commercial premises).

Figure 1 Location map

1 Existing environment

1.1 Sensitive receivers

The Westmead study area is centred on the Westmead metro station construction site. The construction site is located to the south of the existing Westmead Station and is bound by Hawkesbury Road to the west, Hassall Street to the east and Baily Street to the south.

Existing noise levels in this study area are generally controlled by transportation noise from the surrounding road network and existing rail line. The area surrounding the construction site is generally suburban and the nearest receivers are residential.

The Parramatta study area is centred on the Parramatta metro station construction site. The construction site is located between George Street and Macquarie Street, and between Church Street and Smith Street.

Existing noise levels in this study area are controlled by road traffic noise and general urban hum associated with the CBD. As with any CBD, existing noise levels and are relatively high during the daytime, evening and night-time. The area surrounding the construction site is mainly commercial and the nearest receivers are close to the boundary of the site. The nearest receivers are typically of general office or retail use.

1.2 Noise catchment areas

To facilitate the assessment of noise impacts from the project and to apply representative Noise Management Levels (NMLs) to all receivers, receivers adjacent to the Westmead and Parramatta sites have been divided into Noise Catchment Areas (NCAs). The Westmead site contains two noise catchments (NCA01 and NCA02) and NCA03 comprises the Parramatta CBD.

NCAs group individual sensitive receivers by representative traits such as existing noise environment and potential exposure to noise and vibration from the Project.

NCAs established as part of the EIS are summarised in Table 1 and illustrated in Figure 1. Background noise monitoring has been completed as part of the EIS to apply appropriate NML to each NCA.

Table 1 Summary of work areas, Noise Catchment Areas and land uses

NCA	Location	Description
1	Westmead	North of the existing rail corridor in Westmead and mainly residential. 'Other sensitive' receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.
2		South of the existing rail corridor and mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.
3	Parramatta	Covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many 'other sensitive' receivers in this catchment, including Western Sydney University, Arthur Phillip High School, Parramatta Public School, and a number of hotels and places of worship.

2 Assessment framework

2.1 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2. Use of power saws, rock breakers, drills and other tonal or impulsive activities are defined as annoying under the Interim Construction Noise Guideline (ICNG) and are 'highly noise intensive works'.

Table 2 Approved construction hours

CoA	Construction activity	Monday to Friday	Saturday	Sunday / Public holiday
D35	Approved construction	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work (unless approved under EPL or out-of-hours work protocol)
D36	Highly noise intensive works	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work (unless approved under EPL or out-of-hours work protocol)

Notes:
1. if continuously, then not exceeding three hours, with a minimum cessation of work of not less than one hour.

2.2 Noise assessment criteria

2.2.1 Construction noise

The ICNG describes noise in excess of the background level as potentially having an adverse impact on sensitive receivers and increasing the likelihood of complaint. During standard construction hours, where construction noise is within 10 dB(A) of the RBL, impacts would be acceptable.

Where construction noise is more than 10 dB(A) above the RBL during standard construction hours, a residential receiver is considered noise affected and the proponent should undertake all reasonable and feasible steps necessary to manage the impact and consult with the affected community.

Above a $L_{Aeq, 15 minute}$ noise level of 75 dB(A), a receiver is highly affected, requiring consideration of additional mitigation measures including alternative accommodation in the night period.

Outside standard construction hours, construction noise at a residential receiver more than 5 dB(A) above the RBL is taken to be noise affected. Table 1 (reproduced from Table 2 of the ICNG) sets out the NMLs for residences and how they are to be applied.

In addition, annoying noise such as rock hammers, impact piling, or other impulsive noise sources usually result in greater annoyance than continuous construction noise. A 5 dB(A) penalty is applicable to such activities prior to comparison with the NMLs.

2.2.2 Sleep disturbance

The CNVS requires maximum noise levels to be analysed in terms of the extent and number of times the maximum noise exceeds specific noise trigger levels, in general accordance with the Noise Policy for Industry (NPfI) (EPA 2017). These triggers are:

- LAeq, 15 minute 40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and the
- LAmax 52 dBA or the prevailing RBL plus 15 dB, whichever is greater.

The NPfI also recommends the DECCW (2011) Road Noise Policy (RNP) be reviewed for further risk assessment. The RNP recommends maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep and one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

Table 3 Residential noise management levels

Time of day	NML $L_{Aeq\ (15\ min)}$ *	How to apply
Standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Other sensitive land uses, such as schools and offices, typically find noise from construction disruptive when the properties are being used (such as during work and school times). The noise management levels for non-residential receivers set in accordance with the Interim Construction Noise Guideline are provided in Table 4. These levels apply only during hours when the non-residential premises are being used.

The difference between an internal noise level and the external noise level is about 10 dB(A), which provides a conservative assumption that windows are open for ventilation. Buildings where windows are fixed or cannot otherwise be opened may achieve a greater noise level performance.

Table 4 Non-residential sensitive land uses noise management levels

Land use	Noise assessment location	NML ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Places of worship		
Active recreation areas (such as sporting activities and activities which generate their own noise or focus for participants)	External	65
Passive recreation areas (contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External	60
Industrial premises	External	75
Office, retail outlets	External	70

2.3 Project construction noise management levels

The Project specific construction noise management levels for residential receivers have been established in line with the ICNG, based on the RBLs relevant to each NCA. These are presented in Table 5. NMLs for non-residential sensitive receivers are described in Table 4.

Table 5 Project specific construction NMLs

NCA	Noise Management Level, $L_{Aeq\ 15\ minute}$						
	Approved hours		Outside approved hours				
	Noise affected	Highly noise affected	Day	Evening	Night	Sleep disturbance (CNVS)	
						$L_{Aeq,\ 15\ minute}$	L_{Amax}
1	58	75	53	51	46	46	56
2	59	75	54	52	42	42	52
3	68	75	63	58	48	48	58

As part of planning for out of hours works, standard mitigation measures, as described in the CNVMP, are implemented where reasonable and feasible. However, after these measures have been applied, noise and vibration levels may continue to exceed the NMLs.

In this case, additional mitigation measures outlined in the CNVS, which largely focus on engagement with affected sensitive receivers, should be implemented where reasonable and feasible, unless other agreements are in place with the impacted receiver.

Triggers and additional mitigation measures for airborne noise are taken from the Project's OOHW Protocol and summarised in Table 6. Further details of specific additional mitigation measures are described in the CNVS.

Table 6 Triggers for additional mitigation measures – Airborne noise (Sydney Metro 2020)

Construction hours	Class	dB above NML	Additional management measures
Approved hours Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	N	0 to 10	-
	CA	10 to 20	LB
	MI	20 to 30	LB, M, SN
	HI	>30	LB, M, SN
Evening Monday – Friday: 6pm – 10pm Saturday: 7am – 8am, 6pm – 10pm Sunday / PH: 8am – 6pm	N	0 to 10	LB
	CA	10 to 20	LB, M
	MI	20 to 30	LB, M, SN, RO
	HI	> 30	LB, M, SN, IB, PC, RO
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am) Sunday / PH: 6pm –7am	N	0 to 10	LB
	CA	10 to 20	LB, M, SN, RO
	MI	20 to 30	LB, M, SN, IB, PC, RO, AA
	HI	> 30	LB, M, SN, IB, PC, RO, AA

Notes: PC = Phone Calls and emails
M = Monitoring
IB = Individual briefings
AA = Alternative accommodation
SN = Specific notification
LB = Letterbox drops
RO = Project specific respite offer

N = Noticeable CA = Clearly audible MI Moderately intrusive HI = Highly intrusive

2.4 Vibration management

2.4.1 Human comfort

When assessing human exposure to construction-related vibration, the CNVS requires vibration goals to be established using *Environmental Noise Management Assessing Vibration: A Technical Guideline* (DECC 2006), which provides criteria for the assessment of vibration impacts on humans.

Construction activities typically generate vibration of an intermittent nature, which is assessed using a Vibration Dose Value (VDV). Acceptable values of vibration doses are presented in Table 7 for sensitive receivers.

Table 7 VDV Vibration criteria

Receiver type	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings – 16 hour day (7am to 11pm)[1]	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings – 8 hour night (11pm to 7am)[1]	0.13	0.26	0.51

Note 1: Day time and night time as described in BS6472:1992 (as referenced in the CNVS), i.e. a daytime period of 16 h or a night time period of 8 h, for example 23.00 h to 07.00 h.

2.4.2 Buildings

Potential building damage from construction vibration requires the application of values in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings* Part 2. These values are presented in Table 8 and relate to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Table 8 Guideline values for vibration velocity for the effects of short-term vibration on structures (BS 7385).

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz to 50 mm/s at 40 Hz and above

Where vibration may give rise to magnification due to resonance, especially at lower frequencies where lower guide values apply, the guide values may be reduced by 50%. The CNVS describes rock breaking/hammering and sheet piling activities as having potential to cause dynamic loading in some structures (e.g. residences).

For activity involving rock breakers, piling rigs, vibratory rollers, excavators, vibration predominantly occurs at frequencies in the 10 Hz to 100 Hz range. On this basis, a conservative vibration damage screening level is:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

2.4.3 Heritage

Heritage buildings and structures would be assessed under a conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150). Where vibration levels at heritage items are identified as exceeding this screening level, structural assessment would be completed by the Project team to confirm the structure's sensitivity to vibration. If a heritage building or structure is found to be structurally unsound (following inspection) the conservative criterion would stand. Where the structure is suitably sound, the guideline values from Table 8 would be applicable.

2.4.4 Additional mitigation measures

The CNVS recommends additional mitigation measures where all standard mitigation measures to minimise vibration at the nearest receivers have been implemented and vibration is still predicted to exceed the maximum guideline values. The Additional Mitigation Measures Matrix (AMMM) for vibration from the CNVS is presented in Table 9.

Table 9 Additional Vibration Mitigation Measures (CNVS)

Construction hours	Mitigation measures where predicted vibration levels exceed maximum levels
Approved hours Monday – Friday: 7am – 6pm, Saturday: 8am to 6pm	LB, M, RO
Evening Monday – Friday: 6pm – 10pm; Saturday: 7am – 8am, 6pm – 10pm; Sunday / PH: 8am – 6pm	LB, M, IB, PC, RO, SN
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am); Sunday / PH: 6pm –7am	LB, M, IB, PC, RO, SN, AA

3 Impact assessment

3.1 Modelling method

Predictions of noise impacts were performed using KNOWnoise™, a project-specific noise assessment tool developed by Hutchison Weller for the CTP Project. KNOWnoise calculates the maximum $L_{Aeq,15minute}$ noise level for each identified receiver for each proposed activity using predictions from SoundPlan noise modelling software. Predictions include geometric spreading, air and ground absorptions as well as topographical and structural screening and reflection.

The following components were incorporated in the model:

- Topography – Based on terrain data of 1 m resolution.
- Individual sensitive receivers – Worst-affected façade of each building to 700 metres from the works
- Construction noise sources –Activities and equipment provided by GLC were included in the noise model as individual sources across the nominated work areas for each activity. The maximum predicted LAeq noise level within each work area was identified for each receiver.
- Cumulative impacts – all activities with overlapping time periods are included in cumulative results
- Source height – construction noise sources assumed to be at 1.5 metres above ground level.
- Ground Absorption – Ground assumed to be mixed hard and soft with absorption factor of 0.5
- Meteorology –worst-case meteorological conditions (gentle breeze from source to receiver and stable conditions).
- Residential building structures are included in the model, meaning screening provided by neighboring houses is considered.
- Results are shown for all floors of assessed buildings with the worst-case façade result assumed for the whole floor.

Equipment proposed to be used for OOHW activities together with estimated sound power levels for each item are summarised in Appendix A.

The sound power levels and ultimate predicted noise levels will depend on the number of plant items operating at any one time and their precise location relative to a sensitive receiver. In practice, the predicted levels will vary due to plant moving around the site and not operating intensively or concurrently for a 15 minute assessment period. Shielding and reflection provided by buildings will also vary as plant moves around the site. Therefore, predicted noise levels are conservative.

3.2 Predicted noise levels

Predicted impact classes for the Evening period are illustrated graphically in Appendix B. Each identified receiver in the study area has been coloured to highlight the predicted level of impact.

Detailed predicted noise levels for each potentially affected receiver are presented Appendix C.

Table 10 presents the worst-case predicted noise level of 80 dB(A) during the works, resulting in 5 receivers classed as highly noise affected.

Table 10 Summary of maximum predicted noise level and highly affected receivers for the Evening period.

Maximum cumulative predicted $L_{Aeq,\ 15\ minute}$ noise level	80 dB(A)
Number of highly noise affected receivers (>75 dB)	5

With reference to the CNVS, the number of senstive receivers classified in each impact class for each assessment period are summarised in the following tables.

Table 11 Summary of NML exceedance ranges for standard hours.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	25
Clearly Audible	10 <= 20 dB above NML	0
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 12 Summary of NML exceedance ranges for outside standard hours - weekend.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	25
Clearly Audible	10 <= 20 dB above NML	0
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 13 Summary of NML exceedance ranges for outside standard hours - evenings.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	25
Clearly Audible	10 <= 20 dB above NML	0

Impact class	Predicted noise level	Predicted number of receivers
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 14 Summary of NML exceedance ranges for outside standard hours - nights.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	52
Clearly Audible	10 <= 20 dB above NML	0
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

In the event works are planned for more than two consecutive nights, sleep disturbance has been considered. Table 15 summarises the number of residents predicted to exceed the sleep disturbance screening criterion. Further analysis is also provided to indicate the number of receivers expected to be woken, at LAmax noise levels greater than 65 dBA.

Where exceedances of the awakening criteria are predicted, additional care should be taken, and mitigation measures implemented in line with the CNVS.

Table 15 Summary of predicted exceedances of sleep disturbance screening criterion and awakening criterion.

Criterion	Predicted number of receivers
Potentially Sleep Disturbed (exceed RBL + 15 screening criterion)	0
Exceed 65 dBA awakening criterion	0

3.3 Vibration

The CNVS requires attended vibration measurements at commencement of vibration generating activities to confirm vibration levels satisfy the criteria for that activity.

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. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

Based on the proposed work locations and selected equipment, indicative exceedances of the vibration criteria are summarised in Table 16. The exceedances are based on recommended minimum working distances from vibration intensive plant given in Appendix D of the Construction Noise and Vibration Strategy (Transport for NSW 2019). Vibration impacts for each sensitive receiver are listed in Appendix C.

Table 16 Predicted exceedances of vibration criteria

Impact classification	Number of potentially affected receivers
Human comfort	25
Cosmetic damage	1
Heritage structure	0

4 Controls and safeguards

The Project represents a risk of adverse impacts on sensitive receivers, particularly when working close to the project boundary and outside approved hours.

Where short term noise impacts are unavoidable, mitigation measures described in the project construction environment management plan should be implemented together with the recommendations in in Table 14.

Table 17 and additional mitigation measures for each receiver identified in Appendix B and summarised in Table 14.

Table 17 Standard mitigation measures

Community consultation	• Potentially affected receivers will be notified of OOH works in accordance with project requirements. • Where practicable, works will be scheduled to not conflict with major student examination periods, church congregation times, and other sensitive periods identified through community consultation.
Site induction	• All workers will be inducted to the project prior to commencing work and will be cognisant of their noise and vibration obligations under the CNVMP.
Behavioural practices	• Avoid swearing and unnecessary shouting or loud radios onsite. • Avoid dropping materials from height.
Equipment selection	• Priority given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable. • The noise levels of plant and equipment would meet the maximum noise requirements of the CNVS.
Use and siting of plant	• Locate compounds away from sensitive receivers and discourage access from local roads. • Plant used intermittently to be throttled down or shut down. • Noise-emitting plant to be directed away from sensitive receivers where possible. • Stationary plant should be located behind a structure or enclosed if practicable. • Deliveries should be made as far as practical from sensitive receivers. Dedicated loading/unloading sites should be shielded where possible, if close to receivers. • Plan traffic flow, parking and loading/unloading areas to minimise reversing. • Avoid compression breaking on approach to the site. • Where additional activities or plant may result in marginal noise increases and speed works up, consider concentrating activities at one location and complete works as quickly as possible.
Non-tonal reversing alarms.	• Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Noise monitoring	• Monitoring should be completed to verify the assumptions of this CNVIS regarding estimated equipment noise emissions and to ensure compliance with the CNVS.
Vibration monitoring	• Attended vibration measurements should be completed at commencement of vibration generating activities predicted to occur within safe working distances for cosmetic damage. • Where monitoring demonstrates maximum levels exceeded, consider alternative methodologies/equipment
Implement any project specific mitigation measures	
1	Mitigation mesasures as per Project NVMP & DNVIS.

Table 18 Additional mitigation measures

Code	Measure	Description
AA	Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.
M	Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, 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 receiver have 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 has been exceeded so that additional management measures may be implemented.
IB	Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
LB	Letterbox drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.
RO	Respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.
PC	Phone calls	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Appendix A Proposed activities and associated sound power levels

Section 3 - Stage 3 - Installation of Pavement & Reinstatement of Surface

Installation of pipeline, backfill excavations, compact and reinstate surface with asphalt.

19/06/2023 8:00:46 PM - 24/06/2023 5:00:58 AM

Equipment	Quantity	Usage	Reduction	SWL
Bogies	1	30 %	0	95
Plate compactor (small e.g. 60kg)	1	30 %	0	99
Tipper Truck	1	30 %	0	93
Daymakers / Lighting plant	1	100 %	0	93
Light vehicle	1	10 %	0	75

Activity Sound Power Level: 102

* includes 5 dB penalty for potentially annoying characteristics in line with the ICNG

Appendix B Map showing predicted noise impacts by impact class

Appendix C Detailed predictions

C.1 Noise

Assessment: George St Water Discharge Route					NML, LAeq, 15 minute				Sleep, LAmax		Predicted noise level, dBA		Exceedance summary										
														Exceed NML by (dB):				Exceed sleep disturbance by (dB):		Impact classification			
NCA	Rec	Address	Flr	Land use	Day	O/day	Eve	Night	Screen	Awake	Cumulative LAeq, 15 minute	LMax	Highly Affected?	Day	O/day	Eve	Night	Screen	Awake	Day	O/day	Eve	Night
NCA03	746886	"1 BARRACK LANE, PARRAMATTA"	5	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746885	"1 BARRACK LANE, PARRAMATTA"	4	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746884	"1 BARRACK LANE, PARRAMATTA"	3	COM	70	70	70	70			75	83	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746883	"1 BARRACK LANE, PARRAMATTA"	2	COM	70	70	70	70			78	85	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746882	"1 BARRACK LANE, PARRAMATTA"	1	COM	70	70	70	70			80	87	Y	10	10	10	10	-	10	Noticable	Noticable	Noticable	Noticable
NCA03	746687	"91 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746686	"91 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746685	"91 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746684	"91 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746683	"91 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746113	"140 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	746038	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746037	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746036	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745632	"85 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			75	82		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745590	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745589	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			73	80		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745588	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745587	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			76	83	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	744376	"89 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744375	"89 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			76	83	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	744261	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	4	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744260	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	3	COM	70	70	70	70			73	81		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744259	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	2	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	744258	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	1	COM	70	70	70	70			75	82		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable

C.2 Vibration

NCA	Receiver	Address	Land use	Vibration Impact
NCA03	746886	"1 BARRACK LANE, PARRAMATTA"	COM	Human Comfort
NCA03	746885	"1 BARRACK LANE, PARRAMATTA"	COM	Human Comfort
NCA03	746884	"1 BARRACK LANE, PARRAMATTA"	COM	Human Comfort

NCA	Receiver	Address	Land use	Vibration Impact
NCA03	746883	"1 BARRACK LANE, PARRAMATTA"	COM	Human Comfort
NCA03	746882	"1 BARRACK LANE, PARRAMATTA"	COM	Cosmetic
NCA03	746686	"91 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746685	"91 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746684	"91 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746683	"91 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746113	"140 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746039	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746038	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746037	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746036	"LEVEL 6 110 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	745632	"85 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	745591	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	745590	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	745589	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	745588	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	745587	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744376	"89 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744375	"89 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	744261	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	COM	Human Comfort
NCA03	744260	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	COM	Human Comfort
NCA03	744259	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	COM	Human Comfort
NCA03	744258	"MORETON BAY TERRACE SE 12 83 GEORGE ST,"	COM	Human Comfort

Construction noise and vibration impact statement

George St Water Discharge Route			
Project	SMW WTP - Westmead and Parramatta		
Client	Gamuda Laing O'Rourke Consortium		
Assessment Date	02/03/2023	Assessment Id	PARRA-036
Proposed start date	26/06/2023	Proposed end date	30/06/2023

Contents

Acoustic terms and acronyms

AA	Acoustic Advisor
AMM	Additional mitigation measures – applicable where standard measures have been implemented and NML is still expected to be exceeded.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
ICNG	Interim Construction Noise Guideline (Department of Environment and Climate Change 2009)
NCA	Noise Catchment Area
Noise level statistics	L_{A90} - The A-weighted sound pressure level exceeded 90% of the monitoring period. This is considered to represent the background noise. L_{Aeq} - The equivalent continuous A-weighted noise level—the level of noise equivalent to the energy average of noise levels occurring over a measurement period. L_{A1} – The A-weighted sound pressure level exceeded 1% of the monitoring period. L_{Amax} – The maximum A-weighted noise level associated with the measurement period.
NML	Noise Management Level
PPV	Peak Particle Velocity – Measurement of ground-borne vibration in units of mm/s
RBL	Rating Background Level - a single figure that represents the background noise level for assessment purposes
ROL	Road Occupancy Licence – granted by Transport for NSW and required for any activity likely to impact on traffic flow.
SWL	Sound Power Level - The A-weighted sound power level is a logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
SPL	Sound pressure level - This is the level of noise, usually expressed in dB(A), as measured by a standard sound level meter with a pressure microphone. The sound pressure level in dB(A) gives a close indication of the subjective loudness of noise. A technical definition for the sound pressure level, in decibels, is 20 times the logarithm (base 10) of the ratio of any two quantities related to a given sound pressure to a reference pressure (typically 20 µPa equivalent to 0 dB).
Tonal noise	Noise with perceptible and definite pitch or tone
VDV	Vibration dose value – used when assessing intermittent vibration as it is sensitive to peaks in vibration acceleration and accumulates the vibration energy received over the daytime and night-time periods

1 Introduction

1.1 Overview

The Sydney Metro Western Tunnelling Package is being delivered by the Gamuda Australia and Laing O'Rourke Consortium (GLC) and includes twin nine-kilometre tunnels between Sydney Olympic Park and Westmead, excavation of two new metro stations, and a stabling and maintenance facility at Clyde (the Project).

During the Project, there is potential for nearby sensitive receivers to experience adverse impacts relating to noise and vibration. The project's Noise and Vibration Management Sub Plan (NVMP) was developed to satisfy the project's Conditions of Approval (CoA) and addresses the assessment and management of noise and vibration impacts during construction.

Under the NVMP, KNOWnoise™, a project-specific noise prediction tool, has been developed to prepare a Construction noise and vibration impact statement (CNIS) for site and activity-specific noise works and provide ongoing risk analysis during project delivery and for when out-of-hours work is proposed (as per the Project's out-of-hours protocol).

This CNIS has been prepared using KNOWnoise™ and addresses activities for construction of the Westmead and Parramatta station boxes and utilities corridor between the two sites, as illustrated in Figure 1.

The structure of this CNIS includes:

- Section 1.2 – Construction works and hours with justification for these works in Section 1.3
- Section 2 – Existing environment
- Section 3 – Assessment framework including noise and vibration management levels
- Section 4 – Construction noise assessment
- Section 5 – Mitigation and management, including consultation

1.2 Planned works

GLC plans to carry out the works described in Appendix A, which lists each assessed activity, its timing and proposed equipment.

1.3 Justification of the works

In line with the Interim Construction Noise Guidelines (DECC 2009), justification is typically required to work outside approved construction hours. These situations may involve low impact or emergency works and works under an out-of-hours work protocol.

GLC proposes the works subject to this assessment outside approved construction hours for the following reason.

- Works are required to be completed outside of standard construction hours as (a) the applicable council permits and Road Occupancy License (ROL) for access to the footpaths and road network will only be issued for non-peak periods (i.e. weekend, evening and night works) along Smith Street; and (b) works are required to be completed without obstructing access to the public and adjacent commercial premises).

Figure 1 Location map

1 Existing environment

1.1 Sensitive receivers

The Westmead study area is centred on the Westmead metro station construction site. The construction site is located to the south of the existing Westmead Station and is bound by Hawkesbury Road to the west, Hassall Street to the east and Baily Street to the south.

Existing noise levels in this study area are generally controlled by transportation noise from the surrounding road network and existing rail line. The area surrounding the construction site is generally suburban and the nearest receivers are residential.

The Parramatta study area is centred on the Parramatta metro station construction site. The construction site is located between George Street and Macquarie Street, and between Church Street and Smith Street.

Existing noise levels in this study area are controlled by road traffic noise and general urban hum associated with the CBD. As with any CBD, existing noise levels and are relatively high during the daytime, evening and night-time. The area surrounding the construction site is mainly commercial and the nearest receivers are close to the boundary of the site. The nearest receivers are typically of general office or retail use.

1.2 Noise catchment areas

To facilitate the assessment of noise impacts from the project and to apply representative Noise Management Levels (NMLs) to all receivers, receivers adjacent to the Westmead and Parramatta sites have been divided into Noise Catchment Areas (NCAs). The Westmead site contains two noise catchments (NCA01 and NCA02) and NCA03 comprises the Parramatta CBD.

NCAs group individual sensitive receivers by representative traits such as existing noise environment and potential exposure to noise and vibration from the Project.

NCAs established as part of the EIS are summarised in Table 1 and illustrated in Figure 1. Background noise monitoring has been completed as part of the EIS to apply appropriate NML to each NCA.

Table 1 Summary of work areas, Noise Catchment Areas and land uses

NCA	Location	Description
1	Westmead	North of the existing rail corridor in Westmead and mainly residential. 'Other sensitive' receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.
2		South of the existing rail corridor and mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.
3	Parramatta	Covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many 'other sensitive' receivers in this catchment, including Western Sydney University, Arthur Phillip High School, Parramatta Public School, and a number of hotels and places of worship.

2 Assessment framework

2.1 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2. Use of power saws, rock breakers, drills and other tonal or impulsive activities are defined as annoying under the Interim Construction Noise Guideline (ICNG) and are 'highly noise intensive works'.

Table 2 Approved construction hours

CoA	Construction activity	Monday to Friday	Saturday	Sunday / Public holiday
D35	Approved construction	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work (unless approved under EPL or out-of-hours work protocol)
D36	Highly noise intensive works	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work (unless approved under EPL or out-of-hours work protocol)

Notes:

1. if continuously, then not exceeding three hours, with a minimum cessation of work of not less than one hour.

2.2 Noise assessment criteria

2.2.1 Construction noise

The ICNG describes noise in excess of the background level as potentially having an adverse impact on sensitive receivers and increasing the likelihood of complaint. During standard construction hours, where construction noise is within 10 dB(A) of the RBL, impacts would be acceptable.

Where construction noise is more than 10 dB(A) above the RBL during standard construction hours, a residential receiver is considered noise affected and the proponent should undertake all reasonable and feasible steps necessary to manage the impact and consult with the affected community.

Above a $L_{Aeq,\ 15\ minute}$ noise level of 75 dB(A), a receiver is highly affected, requiring consideration of additional mitigation measures including alternative accommodation in the night period.

Outside standard construction hours, construction noise at a residential receiver more than 5 dB(A) above the RBL is taken to be noise affected. Table 1 (reproduced from Table 2 of the ICNG) sets out the NMLs for residences and how they are to be applied.

In addition, annoying noise such as rock hammers, impact piling, or other impulsive noise sources usually result in greater annoyance than continuous construction noise. A 5 dB(A) penalty is applicable to such activities prior to comparison with the NMLs.

2.2.2 Sleep disturbance

The CNVS requires maximum noise levels to be analysed in terms of the extent and number of times the maximum noise exceeds specific noise trigger levels, in general accordance with the Noise Policy for Industry (NPfI) (EPA 2017). These triggers are:

- LAeq, 15 minute 40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and the
- LAmax 52 dBA or the prevailing RBL plus 15 dB, whichever is greater.

The NPfI also recommends the DECCW (2011) Road Noise Policy (RNP) be reviewed for further risk assessment. The RNP recommends maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep and one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

Table 3 Residential noise management levels

Time of day	NML $L_{Aeq\ (15\ min)}$ *	How to apply
Standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Other sensitive land uses, such as schools and offices, typically find noise from construction disruptive when the properties are being used (such as during work and school times). The noise management levels for non-residential receivers set in accordance with the Interim Construction Noise Guideline are provided in Table 4. These levels apply only during hours when the non-residential premises are being used.

The difference between an internal noise level and the external noise level is about 10 dB(A), which provides a conservative assumption that windows are open for ventilation. Buildings where windows are fixed or cannot otherwise be opened may achieve a greater noise level performance.

Table 4 Non-residential sensitive land uses noise management levels

Land use	Noise assessment location	NML ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Places of worship		
Active recreation areas (such as sporting activities and activities which generate their own noise or focus for participants)	External	65
Passive recreation areas (contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External	60
Industrial premises	External	75
Office, retail outlets	External	70

2.3 Project construction noise management levels

The Project specific construction noise management levels for residential receivers have been established in line with the ICNG, based on the RBLs relevant to each NCA. These are presented in Table 5. NMLs for non-residential sensitive receivers are described in Table 4.

Table 5 Project specific construction NMLs

NCA	Noise Management Level, $L_{Aeq\ 15\ minute}$						
	Approved hours		Outside approved hours				
	Noise affected	Highly noise affected	Day	Evening	Night	Sleep disturbance (CNVS)	
						$L_{Aeq,\ 15\ minute}$	L_{Amax}
1	58	75	53	51	46	46	56
2	59	75	54	52	42	42	52
3	68	75	63	58	48	48	58

As part of planning for out of hours works, standard mitigation measures, as described in the CNVMP, are implemented where reasonable and feasible. However, after these measures have been applied, noise and vibration levels may continue to exceed the NMLs.

In this case, additional mitigation measures outlined in the CNVS, which largely focus on engagement with affected sensitive receivers, should be implemented where reasonable and feasible, unless other agreements are in place with the impacted receiver.

Triggers and additional mitigation measures for airborne noise are taken from the Project's OOHW Protocol and summarised in Table 6. Further details of specific additional mitigation measures are described in the CNVS.

Table 6 Triggers for additional mitigation measures – Airborne noise (Sydney Metro 2020)

Construction hours	Class	dB above NML	Additional management measures
Approved hours Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	N	0 to 10	-
	CA	10 to 20	LB
	MI	20 to 30	LB, M, SN
	HI	>30	LB, M, SN
Evening Monday – Friday: 6pm – 10pm Saturday: 7am – 8am, 6pm – 10pm Sunday / PH: 8am – 6pm	N	0 to 10	LB
	CA	10 to 20	LB, M
	MI	20 to 30	LB, M, SN, RO
	HI	> 30	LB, M, SN, IB, PC, RO
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am) Sunday / PH: 6pm –7am	N	0 to 10	LB
	CA	10 to 20	LB, M, SN, RO
	MI	20 to 30	LB, M, SN, IB, PC, RO, AA
	HI	> 30	LB, M, SN, IB, PC, RO, AA

Notes: PC = Phone Calls and emails
M = Monitoring
IB = Individual briefings
AA = Alternative accommodation
SN = Specific notification
LB = Letterbox drops
RO = Project specific respite offer

N = Noticeable CA = Clearly audible MI Moderately intrusive HI = Highly intrusive

2.4 Vibration management

2.4.1 Human comfort

When assessing human exposure to construction-related vibration, the CNVS requires vibration goals to be established using *Environmental Noise Management Assessing Vibration: A Technical Guideline* (DECC 2006), which provides criteria for the assessment of vibration impacts on humans.

Construction activities typically generate vibration of an intermittent nature, which is assessed using a Vibration Dose Value (VDV). Acceptable values of vibration doses are presented in Table 7 for sensitive receivers.

Table 7 VDV Vibration criteria

Receiver type	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings – 16 hour day (7am to 11pm)[1]	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings – 8 hour night (11pm to 7am)[1]	0.13	0.26	0.51

Note 1: Day time and night time as described in BS6472:1992 (as referenced in the CNVS), i.e. a daytime period of 16 h or a night time period of 8 h, for example 23.00 h to 07.00 h.

2.4.2 Buildings

Potential building damage from construction vibration requires the application of values in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings* Part 2. These values are presented in Table 8 and relate to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Table 8 Guideline values for vibration velocity for the effects of short-term vibration on structures (BS 7385).

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz to 50 mm/s at 40 Hz and above

Where vibration may give rise to magnification due to resonance, especially at lower frequencies where lower guide values apply, the guide values may be reduced by 50%. The CNVS describes rock breaking/hammering and sheet piling activities as having potential to cause dynamic loading in some structures (e.g. residences).

For activity involving rock breakers, piling rigs, vibratory rollers, excavators, vibration predominantly occurs at frequencies in the 10 Hz to 100 Hz range. On this basis, a conservative vibration damage screening level is:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

2.4.3 Heritage

Heritage buildings and structures would be assessed under a conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150). Where vibration levels at heritage items are identified as exceeding this screening level, structural assessment would be completed by the Project team to confirm the structure's sensitivity to vibration. If a heritage building or structure is found to be structurally unsound (following inspection) the conservative criterion would stand. Where the structure is suitably sound, the guideline values from Table 8 would be applicable.

2.4.4 Additional mitigation measures

The CNVS recommends additional mitigation measures where all standard mitigation measures to minimise vibration at the nearest receivers have been implemented and vibration is still predicted to exceed the maximum guideline values. The Additional Mitigation Measures Matrix (AMMM) for vibration from the CNVS is presented in Table 9.

Table 9 Additional Vibration Mitigation Measures (CNVS)

Construction hours	Mitigation measures where predicted vibration levels exceed maximum levels
Approved hours Monday – Friday: 7am – 6pm, Saturday: 8am to 6pm	LB, M, RO
Evening Monday – Friday: 6pm – 10pm; Saturday: 7am – 8am, 6pm – 10pm; Sunday / PH: 8am – 6pm	LB, M, IB, PC, RO, SN
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am); Sunday / PH: 6pm –7am	LB, M, IB, PC, RO, SN, AA

3 Impact assessment

3.1 Modelling method

Predictions of noise impacts were performed using KNOWnoise™, a project-specific noise assessment tool developed by Hutchison Weller for the CTP Project. KNOWnoise calculates the maximum $L_{Aeq,15minute}$ noise level for each identified receiver for each proposed activity using predictions from SoundPlan noise modelling software. Predictions include geometric spreading, air and ground absorptions as well as topographical and structural screening and reflection.

The following components were incorporated in the model:

- Topography – Based on terrain data of 1 m resolution.
- Individual sensitive receivers – Worst-affected façade of each building to 700 metres from the works
- Construction noise sources –Activities and equipment provided by GLC were included in the noise model as individual sources across the nominated work areas for each activity. The maximum predicted LAeq noise level within each work area was identified for each receiver.
- Cumulative impacts – all activities with overlapping time periods are included in cumulative results
- Source height – construction noise sources assumed to be at 1.5 metres above ground level.
- Ground Absorption – Ground assumed to be mixed hard and soft with absorption factor of 0.5
- Meteorology –worst-case meteorological conditions (gentle breeze from source to receiver and stable conditions).
- Residential building structures are included in the model, meaning screening provided by neighboring houses is considered.
- Results are shown for all floors of assessed buildings with the worst-case façade result assumed for the whole floor.

Equipment proposed to be used for OOHW activities together with estimated sound power levels for each item are summarised in Appendix A.

The sound power levels and ultimate predicted noise levels will depend on the number of plant items operating at any one time and their precise location relative to a sensitive receiver. In practice, the predicted levels will vary due to plant moving around the site and not operating intensively or concurrently for a 15 minute assessment period. Shielding and reflection provided by buildings will also vary as plant moves around the site. Therefore, predicted noise levels are conservative.

3.2 Predicted noise levels

Predicted impact classes for the Evening period are illustrated graphically in Appendix B. Each identified receiver in the study area has been coloured to highlight the predicted level of impact.

Detailed predicted noise levels for each potentially affected receiver are presented Appendix C.

Table 10 presents the worst-case predicted noise level of 90 dB(A) during the works, resulting in 58 receivers classed as highly noise affected.

Table 10 Summary of maximum predicted noise level and highly affected receivers for the Evening period.

Maximum cumulative predicted $L_{Aeq,\ 15\ minute}$ noise level	90 dB(A)
Number of highly noise affected receivers (>75 dB)	58

With reference to the CNVS, the number of senstive receivers classified in each impact class for each assessment period are summarised in the following tables.

Table 11 Summary of NML exceedance ranges for standard hours.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	89
Clearly Audible	10 <= 20 dB above NML	25
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 12 Summary of NML exceedance ranges for outside standard hours - weekend.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	99
Clearly Audible	10 <= 20 dB above NML	42
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 13 Summary of NML exceedance ranges for outside standard hours - evenings.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	121
Clearly Audible	10 <= 20 dB above NML	37

Impact class	Predicted noise level	Predicted number of receivers
Moderately Intrusive	20 <= 30 dB above NML	6
Highly Intrusive	> 30 dB above NML	0

Table 14 Summary of NML exceedance ranges for outside standard hours - nights.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	133
Clearly Audible	10 <= 20 dB above NML	69
Moderately Intrusive	20 <= 30 dB above NML	18
Highly Intrusive	> 30 dB above NML	6

In the event works are planned for more than two consecutive nights, sleep disturbance has been considered. Table 15 summarises the number of residents predicted to exceed the sleep disturbance screening criterion. Further analysis is also provided to indicate the number of receivers expected to be woken, at LAmax noise levels greater than 65 dBA.

Where exceedances of the awakening criteria are predicted, additional care should be taken, and mitigation measures implemented in line with the CNVS.

Table 15 Summary of predicted exceedances of sleep disturbance screening criterion and awakening criterion.

Criterion	Predicted number of receivers
Potentially Sleep Disturbed (exceed RBL + 15 screening criterion)	0
Exceed 65 dBA awakening criterion	0

3.3 Vibration

The CNVS requires attended vibration measurements at commencement of vibration generating activities to confirm vibration levels satisfy the criteria for that activity.

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. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

Based on the proposed work locations and selected equipment, indicative exceedances of the vibration criteria are summarised in Table 16. The exceedances are based on recommended minimum working distances from vibration intensive plant given in Appendix D of the Construction Noise and Vibration Strategy (Transport for NSW 2019). Vibration impacts for each sensitive receiver are listed in Appendix C.

Table 16 Predicted exceedances of vibration criteria

Impact classification	Number of potentially affected receivers
Human comfort	0
Cosmetic damage	0
Heritage structure	0

4 Controls and safeguards

The Project represents a risk of adverse impacts on sensitive receivers, particularly when working close to the project boundary and outside approved hours.

Where short term noise impacts are unavoidable, mitigation measures described in the project construction environment management plan should be implemented together with the recommendations in in Table 14.

Table 17 and additional mitigation measures for each receiver identified in Appendix B and summarised in Table 14.

Table 17 Standard mitigation measures

Community consultation	• Potentially affected receivers will be notified of OOH works in accordance with project requirements. • Where practicable, works will be scheduled to not conflict with major student examination periods, church congregation times, and other sensitive periods identified through community consultation.
Site induction	• All workers will be inducted to the project prior to commencing work and will be cognisant of their noise and vibration obligations under the CNVMP.
Behavioural practices	• Avoid swearing and unnecessary shouting or loud radios onsite. • Avoid dropping materials from height.
Equipment selection	• Priority given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable. • The noise levels of plant and equipment would meet the maximum noise requirements of the CNVS.
Use and siting of plant	• Locate compounds away from sensitive receivers and discourage access from local roads. • Plant used intermittently to be throttled down or shut down. • Noise-emitting plant to be directed away from sensitive receivers where possible. • Stationary plant should be located behind a structure or enclosed if practicable. • Deliveries should be made as far as practical from sensitive receivers. Dedicated loading/unloading sites should be shielded where possible, if close to receivers. • Plan traffic flow, parking and loading/unloading areas to minimise reversing. • Avoid compression breaking on approach to the site. • Where additional activities or plant may result in marginal noise increases and speed works up, consider concentrating activities at one location and complete works as quickly as possible.
Non-tonal reversing alarms.	• Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Noise monitoring	• Monitoring should be completed to verify the assumptions of this CNVIS regarding estimated equipment noise emissions and to ensure compliance with the CNVS.
Vibration monitoring	• Attended vibration measurements should be completed at commencement of vibration generating activities predicted to occur within safe working distances for cosmetic damage. • Where monitoring demonstrates maximum levels exceeded, consider alternative methodologies/equipment
Implement any project specific mitigation measures	
1	Mitigation mesasures as per Project NVMP & DNVIS.

Table 18 Additional mitigation measures

Code	Measure	Description
AA	Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.
M	Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, 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 receiver have 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 has been exceeded so that additional management measures may be implemented.
IB	Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
LB	Letterbox drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.
RO	Respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.
PC	Phone calls	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Appendix A Proposed activities and associated sound power levels

Section 4 - Stage 1 - Saw Cutting Pavement

Pipeline located below ground. Saw cutting will be required for the removal of the footpath and roadway pavement.
26/06/2023 8:00:37 PM - 30/06/2023 10:00:51 PM

Equipment	Quantity	Usage	Reduction	SWL
Concrete Saw (Std)*	1	30 %	3	111
Daymakers / Lighting plant	1	100 %	0	93
Light vehicle	1	10 %	0	75

Activity Sound Power Level: 111
* includes 5 dB penalty for potentially annoying characteristics in line with the ICNG

Appendix B Map showing predicted noise impacts by impact class

Appendix C Detailed predictions

C.1 Noise

GAMUDA Australia

LAING O'ROURKE

Construction noise impact statement

Assessment: George St Water Discharge Route					NML, LAeq, 15 minute				Sleep, LAmax		Predicted noise level, dBA		Exceedance summary										
														Exceed NML by (dB):				Exceed sleep disturbance by (dB):		Impact classification			
NCA	Rec	Address	Flr	Land use	Day	O/day	Eve	Night	Screen	Awake	Cumulative LAeq, 15 minute	LMax	Highly Affected?	Day	O/day	Eve	Night	Screen	Awake	Day	O/day	Eve	Night
NCA03	747161	"SE 3 LEVEL 2 96 PHILLIP ST, PARRAMATTA"	10	RES	68	63	58	48			60	65		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	747160	"SE 3 LEVEL 2 96 PHILLIP ST, PARRAMATTA"	9	RES	68	63	58	48			60	65		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	747159	"SE 3 LEVEL 2 96 PHILLIP ST, PARRAMATTA"	8	RES	68	63	58	48			59	65		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	747158	"SE 3 LEVEL 2 96 PHILLIP ST, PARRAMATTA"	7	RES	68	63	58	48			59	64		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	747157	"SE 3 LEVEL 2 96 PHILLIP ST, PARRAMATTA"	6	RES	68	63	58	48			59	64		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	747156	"SE 3 LEVEL 2 96 PHILLIP ST, PARRAMATTA"	5	RES	68	63	58	48			58	64		0	0	0	10	-	0	None	None	Noticable	Clearly Audible
NCA03	747155	"SE 3 LEVEL 2 96 PHILLIP ST, PARRAMATTA"	4	RES	68	63	58	48			58	63		0	0	0	10	-	0	None	None	Noticable	Clearly Audible
NCA03	747032	"109-113 GEORGE ST, PARRAMATTA"	22	RES	68	63	58	48			63	68		0	0	5	15	-	5	None	Noticable	Noticable	Clearly Audible
NCA03	747031	"109-113 GEORGE ST, PARRAMATTA"	21	RES	68	63	58	48			66	71		0	3	8	18	-	8	None	Noticable	Noticable	Clearly Audible
NCA03	747030	"109-113 GEORGE ST, PARRAMATTA"	20	RES	68	63	58	48			66	71		0	3	8	18	-	8	None	Noticable	Noticable	Clearly Audible
NCA03	747029	"109-113 GEORGE ST, PARRAMATTA"	19	RES	68	63	58	48			66	71		0	3	8	18	-	8	None	Noticable	Noticable	Clearly Audible
NCA03	747028	"109-113 GEORGE ST, PARRAMATTA"	18	RES	68	63	58	48			65	70		0	2	7	17	-	7	None	Noticable	Noticable	Clearly Audible
NCA03	747027	"109-113 GEORGE ST, PARRAMATTA"	17	RES	68	63	58	48			65	70		0	2	7	17	-	7	None	Noticable	Noticable	Clearly Audible
NCA03	747026	"109-113 GEORGE ST, PARRAMATTA"	16	RES	68	63	58	48			64	70		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	747025	"109-113 GEORGE ST, PARRAMATTA"	15	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	747024	"109-113 GEORGE ST, PARRAMATTA"	14	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	747023	"109-113 GEORGE ST, PARRAMATTA"	13	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	747022	"109-113 GEORGE ST, PARRAMATTA"	12	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	747021	"109-113 GEORGE ST, PARRAMATTA"	11	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	747020	"109-113 GEORGE ST, PARRAMATTA"	10	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	747019	"109-113 GEORGE ST, PARRAMATTA"	9	RES	68	63	58	48			64	70		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	747018	"109-113 GEORGE ST, PARRAMATTA"	8	RES	68	63	58	48			64	70		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	747017	"109-113 GEORGE ST, PARRAMATTA"	7	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	747016	"109-113 GEORGE ST, PARRAMATTA"	6	RES	68	63	58	48			61	66		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	747015	"109-113 GEORGE ST, PARRAMATTA"	5	RES	68	63	58	48			61	66		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	747014	"109-113 GEORGE ST, PARRAMATTA"	4	RES	68	63	58	48			60	65		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	747013	"109-113 GEORGE ST, PARRAMATTA"	3	RES	68	63	58	48			59	65		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	747012	"109-113 GEORGE ST, PARRAMATTA"	2	RES	68	63	58	48			59	64		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	747011	"109-113 GEORGE ST, PARRAMATTA"	1	RES	68	63	58	48			58	64		0	0	0	10	-	0	None	None	Noticable	Clearly Audible
NCA03	746692	"91 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746691	"91 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746690	"91 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			77	83	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746689	"91 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable

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NCA03	746688	"91 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			79	84	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746687	"91 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			80	85	Y	10	10	10	10	-	10	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746686	"91 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			81	86	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746685	"91 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			82	87	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746684	"91 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			83	88	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746683	"91 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			83	89	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746560	"SE 2 LEVEL 2 107 GEORGE ST, PARRAMATTA"	4	RES	68	63	58	48			67	72		0	4	9	19	-	9	None	Noticable	Noticable	Clearly Audible
NCA03	746559	"SE 2 LEVEL 2 107 GEORGE ST, PARRAMATTA"	3	RES	68	63	58	48			66	72		0	3	8	18	-	8	None	Noticable	Noticable	Clearly Audible
NCA03	746558	"SE 2 LEVEL 2 107 GEORGE ST, PARRAMATTA"	2	RES	68	63	58	48			66	71		0	3	8	18	-	8	None	Noticable	Noticable	Clearly Audible
NCA03	746557	"SE 2 LEVEL 2 107 GEORGE ST, PARRAMATTA"	1	RES	68	63	58	48			65	70		0	2	7	17	-	7	None	Noticable	Noticable	Clearly Audible
NCA03	746498	"LEVEL 1 107 PHILLIP ST, PARRAMATTA"	7	COM	65	65	65	65			66	71		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746497	"LEVEL 1 107 PHILLIP ST, PARRAMATTA"	6	COM	65	65	65	65			66	71		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746350	"6-10 CHARLES ST, PA"	16	RES	68	63	58	48			60	65		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	746349	"6-10 CHARLES ST, PA"	15	RES	68	63	58	48			60	65		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	746348	"6-10 CHARLES ST, PA"	14	RES	68	63	58	48			59	65		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	746347	"6-10 CHARLES ST, PA"	13	RES	68	63	58	48			59	64		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	746346	"6-10 CHARLES ST, PA"	12	RES	68	63	58	48			59	64		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	746345	"6-10 CHARLES ST, PA"	11	RES	68	63	58	48			59	64		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	746344	"6-10 CHARLES ST, PA"	10	RES	68	63	58	48			58	63		0	0	0	10	-	0	None	None	Noticable	Clearly Audible
NCA03	746173	"150 GEORGE ST, PARRAMATTA"	15	COM	70	70	70	70			73	79		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746172	"150 GEORGE ST, PARRAMATTA"	14	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746171	"150 GEORGE ST, PARRAMATTA"	13	COM	70	70	70	70			74	80		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746170	"150 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			75	80		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746169	"150 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746168	"150 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746167	"150 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746166	"150 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			77	83	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746165	"150 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746164	"150 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			79	84	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746163	"150 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			79	85	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746162	"150 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			81	86	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746161	"150 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			82	87	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746160	"150 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			83	88	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746159	"150 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			84	89	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746154	"150 GEORGE ST, PARRAMATTA"	23	COM	70	70	70	70			70	75		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	746153	"150 GEORGE ST, PARRAMATTA"	22	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable

NCA03	746152	"150 GEORGE ST, PARRAMATTA"	21	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746151	"150 GEORGE ST, PARRAMATTA"	20	COM	70	70	70	70			71	77		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746150	"150 GEORGE ST, PARRAMATTA"	19	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746149	"150 GEORGE ST, PARRAMATTA"	18	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746148	"150 GEORGE ST, PARRAMATTA"	17	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746147	"150 GEORGE ST, PARRAMATTA"	16	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746113	"140 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			82	87	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746012	"95-101 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			74	80		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746011	"95-101 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			75	80	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746010	"95-101 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746009	"95-101 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			77	82	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746008	"95-101 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			78	83	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746007	"95-101 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			79	85	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746006	"95-101 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			81	86	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746005	"95-101 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			83	88	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746004	"95-101 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			85	90	Y	15	15	15	15	-	15	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746003	"95-101 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			88	93	Y	18	18	18	18	-	18	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746002	"95-101 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			90	95	Y	20	20	20	20	-	20	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746001	"95-101 GEORGE ST, PARRAMATTA"	16	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746000	"95-101 GEORGE ST, PARRAMATTA"	15	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745999	"95-101 GEORGE ST, PARRAMATTA"	14	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745998	"95-101 GEORGE ST, PARRAMATTA"	13	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745997	"95-101 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			74	79		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745800	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	18	EDU	55	55	55	55			61	67		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745799	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	17	EDU	55	55	55	55			61	67		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745798	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	16	EDU	55	55	55	55			61	67		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745797	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	15	EDU	55	55	55	55			61	67		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745796	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	14	EDU	55	55	55	55			61	67		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745795	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	13	EDU	55	55	55	55			62	67		7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745794	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	12	EDU	55	55	55	55			62	67		7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745793	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	11	EDU	55	55	55	55			62	67		7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745792	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	10	EDU	55	55	55	55			61	67		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745791	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	9	EDU	55	55	55	55			61	66		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745790	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	8	EDU	55	55	55	55			61	66		6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745789	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	7	EDU	55	55	55	55			60	65		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745788	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	6	EDU	55	55	55	55			60	65		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable

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NCA03	745787	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	5	EDU	55	55	55	55			59	64		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745786	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	4	EDU	55	55	55	55			58	64		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745785	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	3	EDU	55	55	55	55			58	63		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745784	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	2	EDU	55	55	55	55			57	62		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745596	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			75	80		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745595	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			75	81	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745594	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			76	81	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745593	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			77	83	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745592	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			79	84	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	745591	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			80	85	Y	10	10	10	10	-	10	Noticable	Noticable	Noticable	Noticable
NCA03	745590	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			82	87	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745589	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			84	89	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745588	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			87	92	Y	17	17	17	17	-	17	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745587	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			90	95	Y	20	20	20	20	-	20	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745463	"130 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			70	75		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745462	"130 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745461	"130 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745460	"130 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745459	"130 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			71	76		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745458	"130 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			71	77		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745457	"130 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			71	77		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745456	"130 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			71	77		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745455	"130 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			70	76		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745130	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	10	RES	68	63	58	48			65	70		0	2	7	17	-	7	None	Noticable	Noticable	Clearly Audible
NCA03	745129	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	9	RES	68	63	58	48			65	70		0	2	7	17	-	7	None	Noticable	Noticable	Clearly Audible
NCA03	745128	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	8	RES	68	63	58	48			65	70		0	2	7	17	-	7	None	Noticable	Noticable	Clearly Audible
NCA03	745127	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	7	RES	68	63	58	48			65	70		0	2	7	17	-	7	None	Noticable	Noticable	Clearly Audible
NCA03	745126	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	6	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	745125	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	5	RES	68	63	58	48			64	69		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	745124	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	4	RES	68	63	58	48			63	68		0	0	5	15	-	5	None	Noticable	Noticable	Clearly Audible
NCA03	745123	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	3	RES	68	63	58	48			63	68		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	745122	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	2	RES	68	63	58	48			62	67		0	0	4	14	-	4	None	None	Noticable	Clearly Audible
NCA03	745121	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	1	RES	68	63	58	48			61	67		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	744949	"30 CHARLES ST, PARRAMATTA"	11	RES	68	63	58	48			75	80		7	12	17	27	-	17	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744948	"30 CHARLES ST, PARRAMATTA"	10	RES	68	63	58	48			75	80	Y	7	12	17	27	-	17	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744947	"30 CHARLES ST, PARRAMATTA"	9	RES	68	63	58	48			76	81	Y	8	13	18	28	-	18	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive

NCA03	744946	"30 CHARLES ST, PARRAMATTA"	8	RES	68	63	58	48			77	82	Y	9	14	19	29	-	19	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744945	"30 CHARLES ST, PARRAMATTA"	7	RES	68	63	58	48			77	82	Y	9	14	19	29	-	19	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744944	"30 CHARLES ST, PARRAMATTA"	6	RES	68	63	58	48			78	83	Y	10	15	20	30	-	20	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744943	"30 CHARLES ST, PARRAMATTA"	5	RES	68	63	58	48			79	84	Y	11	16	21	31	-	21	Clearly Audible	Clearly Audible	Moderately Intrusive	Highly Intrusive
NCA03	744942	"30 CHARLES ST, PARRAMATTA"	4	RES	68	63	58	48			79	85	Y	11	16	21	31	-	21	Clearly Audible	Clearly Audible	Moderately Intrusive	Highly Intrusive
NCA03	744941	"30 CHARLES ST, PARRAMATTA"	3	RES	68	63	58	48			80	85	Y	12	17	22	32	-	22	Clearly Audible	Clearly Audible	Moderately Intrusive	Highly Intrusive
NCA03	744940	"30 CHARLES ST, PARRAMATTA"	2	RES	68	63	58	48			80	86	Y	12	17	22	32	-	22	Clearly Audible	Clearly Audible	Moderately Intrusive	Highly Intrusive
NCA03	744939	"30 CHARLES ST, PARRAMATTA"	1	RES	68	63	58	48			81	86	Y	13	18	23	33	-	23	Clearly Audible	Clearly Audible	Moderately Intrusive	Highly Intrusive
NCA03	744938	"30 CHARLES ST, PARRAMATTA"	14	RES	68	63	58	48			73	78		5	10	15	25	-	15	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744937	"30 CHARLES ST, PARRAMATTA"	13	RES	68	63	58	48			73	79		5	10	15	25	-	15	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744936	"30 CHARLES ST, PARRAMATTA"	12	RES	68	63	58	48			74	79		6	11	16	26	-	16	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744903	"22 CHARLES ST, PARRAMATTA"	2	RES	68	63	58	48			78	83	Y	10	15	20	30	-	20	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744902	"22 CHARLES ST, PARRAMATTA"	1	RES	68	63	58	48			78	83	Y	10	15	20	30	-	20	Clearly Audible	Clearly Audible	Moderately Intrusive	Highly Intrusive
NCA03	744901	"22 CHARLES ST, PARRAMATTA"	4	RES	68	63	58	48			77	82	Y	9	14	19	29	-	19	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744900	"22 CHARLES ST, PARRAMATTA"	3	RES	68	63	58	48			78	83	Y	10	15	20	30	-	20	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744899	"22 CHARLES ST, PARRAMATTA"	10	RES	68	63	58	48			74	79		6	11	16	26	-	16	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744898	"22 CHARLES ST, PARRAMATTA"	9	RES	68	63	58	48			74	80		6	11	16	26	-	16	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744897	"22 CHARLES ST, PARRAMATTA"	8	RES	68	63	58	48			75	80		7	12	17	27	-	17	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744896	"22 CHARLES ST, PARRAMATTA"	7	RES	68	63	58	48			75	81	Y	7	12	17	27	-	17	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744895	"22 CHARLES ST, PARRAMATTA"	6	RES	68	63	58	48			76	81	Y	8	13	18	28	-	18	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744894	"22 CHARLES ST, PARRAMATTA"	5	RES	68	63	58	48			77	82	Y	9	14	19	29	-	19	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744376	"89 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			73	78		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	744375	"89 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			72	77		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable

C.2 Vibration

NCA	Receiver	Address	Land use	Vibration Impact

George St Water Discharge Route

Project	SMW WTP - Westmead and Parramatta
Client	Gamuda Laing O'Rourke Consortium

Assessment Date	02/03/2023	Assessment Id	PARRA-036
Proposed start date	26/06/2023	Proposed end date	01/07/2023

Contents

Acoustic terms and acronyms

AA	Acoustic Advisor
AMM	Additional mitigation measures – applicable where standard measures have been implemented and NML is still expected to be exceeded.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
ICNG	Interim Construction Noise Guideline (Department of Environment and Climate Change 2009)
NCA	Noise Catchment Area
Noise level statistics	L_{A90} - The A-weighted sound pressure level exceeded 90% of the monitoring period. This is considered to represent the background noise. L_{Aeq} - The equivalent continuous A-weighted noise level—the level of noise equivalent to the energy average of noise levels occurring over a measurement period. L_{A1} – The A-weighted sound pressure level exceeded 1% of the monitoring period. L_{Amax} – The maximum A-weighted noise level associated with the measurement period.
NML	Noise Management Level
PPV	Peak Particle Velocity – Measurement of ground-borne vibration in units of mm/s
RBL	Rating Background Level - a single figure that represents the background noise level for assessment purposes
ROL	Road Occupancy Licence – granted by Transport for NSW and required for any activity likely to impact on traffic flow.
SWL	Sound Power Level - The A-weighted sound power level is a logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
SPL	Sound pressure level - This is the level of noise, usually expressed in dB(A), as measured by a standard sound level meter with a pressure microphone. The sound pressure level in dB(A) gives a close indication of the subjective loudness of noise. A technical definition for the sound pressure level, in decibels, is 20 times the logarithm (base 10) of the ratio of any two quantities related to a given sound pressure to a reference pressure (typically 20 µPa equivalent to 0 dB).
Tonal noise	Noise with perceptible and definite pitch or tone
VDV	Vibration dose value – used when assessing intermittent vibration as it is sensitive to peaks in vibration acceleration and accumulates the vibration energy received over the daytime and night-time periods

1 Introduction

1.1 Overview

The Sydney Metro Western Tunnelling Package is being delivered by the Gamuda Australia and Laing O'Rourke Consortium (GLC) and includes twin nine-kilometre tunnels between Sydney Olympic Park and Westmead, excavation of two new metro stations, and a stabling and maintenance facility at Clyde (the Project).

During the Project, there is potential for nearby sensitive receivers to experience adverse impacts relating to noise and vibration. The project's Noise and Vibration Management Sub Plan (NVMP) was developed to satisfy the project's Conditions of Approval (CoA) and addresses the assessment and management of noise and vibration impacts during construction.

Under the NVMP, KNOWnoise™, a project-specific noise prediction tool, has been developed to prepare a Construction noise and vibration impact statement (CNIS) for site and activity-specific noise works and provide ongoing risk analysis during project delivery and for when out-of-hours work is proposed (as per the Project's out-of-hours protocol).

This CNIS has been prepared using KNOWnoise™ and addresses activities for construction of the Westmead and Parramatta station boxes and utilities corridor between the two sites, as illustrated in Figure 1.

The structure of this CNIS includes:

- Section 1.2 – Construction works and hours with justification for these works in Section 1.3
- Section 2 – Existing environment
- Section 3 – Assessment framework including noise and vibration management levels
- Section 4 – Construction noise assessment
- Section 5 – Mitigation and management, including consultation

1.2 Planned works

GLC plans to carry out the works described in Appendix A, which lists each assessed activity, its timing and proposed equipment.

1.3 Justification of the works

In line with the Interim Construction Noise Guidelines (DECC 2009), justification is typically required to work outside approved construction hours. These situations may involve low impact or emergency works and works under an out-of-hours work protocol.

GLC proposes the works subject to this assessment outside approved construction hours for the following reason.

- Works are required to be completed outside of standard construction hours as (a) the applicable council permits and Road Occupancy License (ROL) for access to the footpaths and road network will only be issued for non-peak periods (i.e. weekend, evening and night works) along Smith Street; and (b) works are required to be completed without obstructing access to the public and adjacent commercial premises).

Figure 1 Location map

1 Existing environment

1.1 Sensitive receivers

The Westmead study area is centred on the Westmead metro station construction site. The construction site is located to the south of the existing Westmead Station and is bound by Hawkesbury Road to the west, Hassall Street to the east and Baily Street to the south.

Existing noise levels in this study area are generally controlled by transportation noise from the surrounding road network and existing rail line. The area surrounding the construction site is generally suburban and the nearest receivers are residential.

The Parramatta study area is centred on the Parramatta metro station construction site. The construction site is located between George Street and Macquarie Street, and between Church Street and Smith Street.

Existing noise levels in this study area are controlled by road traffic noise and general urban hum associated with the CBD. As with any CBD, existing noise levels and are relatively high during the daytime, evening and night-time. The area surrounding the construction site is mainly commercial and the nearest receivers are close to the boundary of the site. The nearest receivers are typically of general office or retail use.

1.2 Noise catchment areas

To facilitate the assessment of noise impacts from the project and to apply representative Noise Management Levels (NMLs) to all receivers, receivers adjacent to the Westmead and Parramatta sites have been divided into Noise Catchment Areas (NCAs). The Westmead site contains two noise catchments (NCA01 and NCA02) and NCA03 comprises the Parramatta CBD.

NCAs group individual sensitive receivers by representative traits such as existing noise environment and potential exposure to noise and vibration from the Project.

NCAs established as part of the EIS are summarised in Table 1 and illustrated in Figure 1. Background noise monitoring has been completed as part of the EIS to apply appropriate NML to each NCA.

Table 1 Summary of work areas, Noise Catchment Areas and land uses

NCA	Location	Description
1	Westmead	North of the existing rail corridor in Westmead and mainly residential. 'Other sensitive' receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.
2		South of the existing rail corridor and mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.
3	Parramatta	Covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many 'other sensitive' receivers in this catchment, including Western Sydney University, Arthur Phillip High School, Parramatta Public School, and a number of hotels and places of worship.

2 Assessment framework

2.1 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2. Use of power saws, rock breakers, drills and other tonal or impulsive activities are defined as annoying under the Interim Construction Noise Guideline (ICNG) and are 'highly noise intensive works'.

Table 2 Approved construction hours

CoA	Construction activity	Monday to Friday	Saturday	Sunday / Public holiday
D35	Approved construction	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work (unless approved under EPL or out-of-hours work protocol)
D36	Highly noise intensive works	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work (unless approved under EPL or out-of-hours work protocol)

Notes:

1. if continuously, then not exceeding three hours, with a minimum cessation of work of not less than one hour.

2.2 Noise assessment criteria

2.2.1 Construction noise

The ICNG describes noise in excess of the background level as potentially having an adverse impact on sensitive receivers and increasing the likelihood of complaint. During standard construction hours, where construction noise is within 10 dB(A) of the RBL, impacts would be acceptable.

Where construction noise is more than 10 dB(A) above the RBL during standard construction hours, a residential receiver is considered noise affected and the proponent should undertake all reasonable and feasible steps necessary to manage the impact and consult with the affected community.

Above a $L_{Aeq,\ 15\ minute}$ noise level of 75 dB(A), a receiver is highly affected, requiring consideration of additional mitigation measures including alternative accommodation in the night period.

Outside standard construction hours, construction noise at a residential receiver more than 5 dB(A) above the RBL is taken to be noise affected. Table 1 (reproduced from Table 2 of the ICNG) sets out the NMLs for residences and how they are to be applied.

In addition, annoying noise such as rock hammers, impact piling, or other impulsive noise sources usually result in greater annoyance than continuous construction noise. A 5 dB(A) penalty is applicable to such activities prior to comparison with the NMLs.

2.2.2 Sleep disturbance

The CNVS requires maximum noise levels to be analysed in terms of the extent and number of times the maximum noise exceeds specific noise trigger levels, in general accordance with the Noise Policy for Industry (NPfI) (EPA 2017). These triggers are:

- LAeq, 15 minute 40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and the
- LAmax 52 dBA or the prevailing RBL plus 15 dB, whichever is greater.

The NPfI also recommends the DECCW (2011) Road Noise Policy (RNP) be reviewed for further risk assessment. The RNP recommends maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep and one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

Table 3 Residential noise management levels

Time of day	NML $L_{Aeq\ (15\ min)}$ *	How to apply
Standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Other sensitive land uses, such as schools and offices, typically find noise from construction disruptive when the properties are being used (such as during work and school times). The noise management levels for non-residential receivers set in accordance with the Interim Construction Noise Guideline are provided in Table 4. These levels apply only during hours when the non-residential premises are being used.

The difference between an internal noise level and the external noise level is about 10 dB(A), which provides a conservative assumption that windows are open for ventilation. Buildings where windows are fixed or cannot otherwise be opened may achieve a greater noise level performance.

Table 4 Non-residential sensitive land uses noise management levels

Land use	Noise assessment location	NML ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Places of worship		
Active recreation areas (such as sporting activities and activities which generate their own noise or focus for participants)	External	65
Passive recreation areas (contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External	60
Industrial premises	External	75
Office, retail outlets	External	70

2.3 Project construction noise management levels

The Project specific construction noise management levels for residential receivers have been established in line with the ICNG, based on the RBLs relevant to each NCA. These are presented in Table 5. NMLs for non-residential sensitive receivers are described in Table 4.

Table 5 Project specific construction NMLs

NCA	Noise Management Level, $L_{Aeq\ 15\ minute}$						
	Approved hours		Outside approved hours				
	Noise affected	Highly noise affected	Day	Evening	Night	Sleep disturbance (CNVS)	
						$L_{Aeq,\ 15\ minute}$	L_{Amax}
1	58	75	53	51	46	46	56
2	59	75	54	52	42	42	52
3	68	75	63	58	48	48	58

As part of planning for out of hours works, standard mitigation measures, as described in the CNVMP, are implemented where reasonable and feasible. However, after these measures have been applied, noise and vibration levels may continue to exceed the NMLs.

In this case, additional mitigation measures outlined in the CNVS, which largely focus on engagement with affected sensitive receivers, should be implemented where reasonable and feasible, unless other agreements are in place with the impacted receiver.

Triggers and additional mitigation measures for airborne noise are taken from the Project's OOHW Protocol and summarised in Table 6. Further details of specific additional mitigation measures are described in the CNVS.

Table 6 Triggers for additional mitigation measures – Airborne noise (Sydney Metro 2020)

Construction hours	Class	dB above NML	Additional management measures
Approved hours Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	N	0 to 10	-
	CA	10 to 20	LB
	MI	20 to 30	LB, M, SN
	HI	>30	LB, M, SN
Evening Monday – Friday: 6pm – 10pm Saturday: 7am – 8am, 6pm – 10pm Sunday / PH: 8am – 6pm	N	0 to 10	LB
	CA	10 to 20	LB, M
	MI	20 to 30	LB, M, SN, RO
	HI	> 30	LB, M, SN, IB, PC, RO
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am) Sunday / PH: 6pm –7am	N	0 to 10	LB
	CA	10 to 20	LB, M, SN, RO
	MI	20 to 30	LB, M, SN, IB, PC, RO, AA
	HI	> 30	LB, M, SN, IB, PC, RO, AA

Notes: PC = Phone Calls and emails
M = Monitoring
IB = Individual briefings
AA = Alternative accommodation
SN = Specific notification
LB = Letterbox drops
RO = Project specific respite offer

N = Noticeable CA = Clearly audible MI Moderately intrusive HI = Highly intrusive

2.4 Vibration management

2.4.1 Human comfort

When assessing human exposure to construction-related vibration, the CNVS requires vibration goals to be established using *Environmental Noise Management Assessing Vibration: A Technical Guideline* (DECC 2006), which provides criteria for the assessment of vibration impacts on humans.

Construction activities typically generate vibration of an intermittent nature, which is assessed using a Vibration Dose Value (VDV). Acceptable values of vibration doses are presented in Table 7 for sensitive receivers.

Table 7 VDV Vibration criteria

Receiver type	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings – 16 hour day (7am to 11pm)[1]	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings – 8 hour night (11pm to 7am)[1]	0.13	0.26	0.51

Note 1: Day time and night time as described in BS6472:1992 (as referenced in the CNVS), i.e. a daytime period of 16 h or a night time period of 8 h, for example 23.00 h to 07.00 h.

2.4.2 Buildings

Potential building damage from construction vibration requires the application of values in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings* Part 2. These values are presented in Table 8 and relate to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Table 8 Guideline values for vibration velocity for the effects of short-term vibration on structures (BS 7385).

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz to 50 mm/s at 40 Hz and above

Where vibration may give rise to magnification due to resonance, especially at lower frequencies where lower guide values apply, the guide values may be reduced by 50%. The CNVS describes rock breaking/hammering and sheet piling activities as having potential to cause dynamic loading in some structures (e.g. residences).

For activity involving rock breakers, piling rigs, vibratory rollers, excavators, vibration predominantly occurs at frequencies in the 10 Hz to 100 Hz range. On this basis, a conservative vibration damage screening level is:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

2.4.3 Heritage

Heritage buildings and structures would be assessed under a conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150). Where vibration levels at heritage items are identified as exceeding this screening level, structural assessment would be completed by the Project team to confirm the structure's sensitivity to vibration. If a heritage building or structure is found to be structurally unsound (following inspection) the conservative criterion would stand. Where the structure is suitably sound, the guideline values from Table 8 would be applicable.

2.4.4 Additional mitigation measures

The CNVS recommends additional mitigation measures where all standard mitigation measures to minimise vibration at the nearest receivers have been implemented and vibration is still predicted to exceed the maximum guideline values. The Additional Mitigation Measures Matrix (AMMM) for vibration from the CNVS is presented in Table 9.

Table 9 Additional Vibration Mitigation Measures (CNVS)

Construction hours	Mitigation measures where predicted vibration levels exceed maximum levels
Approved hours Monday – Friday: 7am – 6pm, Saturday: 8am to 6pm	LB, M, RO
Evening Monday – Friday: 6pm – 10pm; Saturday: 7am – 8am, 6pm – 10pm; Sunday / PH: 8am – 6pm	LB, M, IB, PC, RO, SN
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am); Sunday / PH: 6pm –7am	LB, M, IB, PC, RO, SN, AA

3 Impact assessment

3.1 Modelling method

Predictions of noise impacts were performed using KNOWnoise™, a project-specific noise assessment tool developed by Hutchison Weller for the CTP Project. KNOWnoise calculates the maximum $L_{Aeq,15minute}$ noise level for each identified receiver for each proposed activity using predictions from SoundPlan noise modelling software. Predictions include geometric spreading, air and ground absorptions as well as topographical and structural screening and reflection.

The following components were incorporated in the model:

- Topography – Based on terrain data of 1 m resolution.
- Individual sensitive receivers – Worst-affected façade of each building to 700 metres from the works
- Construction noise sources –Activities and equipment provided by GLC were included in the noise model as individual sources across the nominated work areas for each activity. The maximum predicted LAeq noise level within each work area was identified for each receiver.
- Cumulative impacts – all activities with overlapping time periods are included in cumulative results
- Source height – construction noise sources assumed to be at 1.5 metres above ground level.
- Ground Absorption – Ground assumed to be mixed hard and soft with absorption factor of 0.5
- Meteorology –worst-case meteorological conditions (gentle breeze from source to receiver and stable conditions).
- Residential building structures are included in the model, meaning screening provided by neighboring houses is considered.
- Results are shown for all floors of assessed buildings with the worst-case façade result assumed for the whole floor.

Equipment proposed to be used for OOHW activities together with estimated sound power levels for each item are summarised in Appendix A.

The sound power levels and ultimate predicted noise levels will depend on the number of plant items operating at any one time and their precise location relative to a sensitive receiver. In practice, the predicted levels will vary due to plant moving around the site and not operating intensively or concurrently for a 15 minute assessment period. Shielding and reflection provided by buildings will also vary as plant moves around the site. Therefore, predicted noise levels are conservative.

3.2 Predicted noise levels

Predicted impact classes for the Evening period are illustrated graphically in Appendix B. Each identified receiver in the study area has been coloured to highlight the predicted level of impact.

Detailed predicted noise levels for each potentially affected receiver are presented Appendix C.

Table 10 presents the worst-case predicted noise level of 89 dB(A) during the works, resulting in 47 receivers classed as highly noise affected.

Table 10 Summary of maximum predicted noise level and highly affected receivers for the Evening period.

Maximum cumulative predicted $L_{Aeq,\ 15\ minute}$ noise level	89 dB(A)
Number of highly noise affected receivers (>75 dB)	47

With reference to the CNVS, the number of senstive receivers classified in each impact class for each assessment period are summarised in the following tables.

Table 11 Summary of NML exceedance ranges for standard hours.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	81
Clearly Audible	10 <= 20 dB above NML	18
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 12 Summary of NML exceedance ranges for outside standard hours - weekend.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	78
Clearly Audible	10 <= 20 dB above NML	34
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 13 Summary of NML exceedance ranges for outside standard hours - evenings.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	97
Clearly Audible	10 <= 20 dB above NML	36

Impact class	Predicted noise level	Predicted number of receivers
Moderately Intrusive	20 <= 30 dB above NML	3
Highly Intrusive	> 30 dB above NML	0

Table 14 Summary of NML exceedance ranges for outside standard hours - nights.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	121
Clearly Audible	10 <= 20 dB above NML	52
Moderately Intrusive	20 <= 30 dB above NML	21
Highly Intrusive	> 30 dB above NML	3

In the event works are planned for more than two consecutive nights, sleep disturbance has been considered. Table 15 summarises the number of residents predicted to exceed the sleep disturbance screening criterion. Further analysis is also provided to indicate the number of receivers expected to be woken, at LAmax noise levels greater than 65 dBA.

Where exceedances of the awakening criteria are predicted, additional care should be taken, and mitigation measures implemented in line with the CNVS.

Table 15 Summary of predicted exceedances of sleep disturbance screening criterion and awakening criterion.

Criterion	Predicted number of receivers
Potentially Sleep Disturbed (exceed RBL + 15 screening criterion)	0
Exceed 65 dBA awakening criterion	0

3.3 Vibration

The CNVS requires attended vibration measurements at commencement of vibration generating activities to confirm vibration levels satisfy the criteria for that activity.

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. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

Based on the proposed work locations and selected equipment, indicative exceedances of the vibration criteria are summarised in Table 16. The exceedances are based on recommended minimum working distances from vibration intensive plant given in Appendix D of the Construction Noise and Vibration Strategy (Transport for NSW 2019). Vibration impacts for each sensitive receiver are listed in Appendix C.

Table 16 Predicted exceedances of vibration criteria

Impact classification	Number of potentially affected receivers
Human comfort	0
Cosmetic damage	0
Heritage structure	0

4 Controls and safeguards

The Project represents a risk of adverse impacts on sensitive receivers, particularly when working close to the project boundary and outside approved hours.

Where short term noise impacts are unavoidable, mitigation measures described in the project construction environment management plan should be implemented together with the recommendations in in Table 14.

Table 17 and additional mitigation measures for each receiver identified in Appendix B and summarised in Table 14.

Table 17 Standard mitigation measures

Community consultation	• Potentially affected receivers will be notified of OOH works in accordance with project requirements. • Where practicable, works will be scheduled to not conflict with major student examination periods, church congregation times, and other sensitive periods identified through community consultation.
Site induction	• All workers will be inducted to the project prior to commencing work and will be cognisant of their noise and vibration obligations under the CNVMP.
Behavioural practices	• Avoid swearing and unnecessary shouting or loud radios onsite. • Avoid dropping materials from height.
Equipment selection	• Priority given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable. • The noise levels of plant and equipment would meet the maximum noise requirements of the CNVS.
Use and siting of plant	• Locate compounds away from sensitive receivers and discourage access from local roads. • Plant used intermittently to be throttled down or shut down. • Noise-emitting plant to be directed away from sensitive receivers where possible. • Stationary plant should be located behind a structure or enclosed if practicable. • Deliveries should be made as far as practical from sensitive receivers. Dedicated loading/unloading sites should be shielded where possible, if close to receivers. • Plan traffic flow, parking and loading/unloading areas to minimise reversing. • Avoid compression breaking on approach to the site. • Where additional activities or plant may result in marginal noise increases and speed works up, consider concentrating activities at one location and complete works as quickly as possible.
Non-tonal reversing alarms.	• Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Noise monitoring	• Monitoring should be completed to verify the assumptions of this CNVIS regarding estimated equipment noise emissions and to ensure compliance with the CNVS.
Vibration monitoring	• Attended vibration measurements should be completed at commencement of vibration generating activities predicted to occur within safe working distances for cosmetic damage. • Where monitoring demonstrates maximum levels exceeded, consider alternative methodologies/equipment
Implement any project specific mitigation measures	
1	Mitigation mesasures as per Project NVMP & DNVIS.

Table 18 Additional mitigation measures

Code	Measure	Description
AA	Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.
M	Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, 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 receiver have 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 has been exceeded so that additional management measures may be implemented.
IB	Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
LB	Letterbox drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.
RO	Respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.
PC	Phone calls	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Appendix A Proposed activities and associated sound power levels

Section 4 - Stage 2 - NDD & Pavement Removal

NDD and removal of pavement is required to be lifted to allow for the discharge route piping.
26/06/2023 8:00:05 PM - 01/07/2023 5:00:20 AM

Equipment	Quantity	Usage	Reduction	SWL
Bogies	1	30 %	0	95
Excavator (06 tonne)	1	40 %	0	90
Tipper Truck	1	30 %	0	93
Vacc truck	1	50 %	0	109
Daymakers / Lighting plant	1	100 %	0	93
Light vehicle	1	10 %	0	75

Activity Sound Power Level: 109
* includes 5 dB penalty for potentially annoying characteristics in line with the ICNG

Appendix B Map showing predicted noise impacts by impact class

Appendix C Detailed predictions

C.1 Noise

GAMUDA Australia

LAING O'ROURKE

Construction noise impact statement

Assessment: George St Water Discharge Route					NML, LAeq, 15 minute				Sleep, LAmax		Predicted noise level, dBA		Exceedance summary										
														Exceed NML by (dB):				Exceed sleep disturbance by (dB):		Impact classification			
NCA	Rec	Address	Flr	Land use	Day	O/day	Eve	Night	Screen	Awake	Cumulative LAeq, 15 minute	LMax	Highly Affected?	Day	O/day	Eve	Night	Screen	Awake	Day	O/day	Eve	Night
NCA03	747161	"SE 3 LEVEL 2 96 PHILLIP ST, PARRAMATTA"	10	RES	68	63	58	48			59	66		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	747160	"SE 3 LEVEL 2 96 PHILLIP ST, PARRAMATTA"	9	RES	68	63	58	48			58	66		0	0	0	10	-	0	None	None	Noticable	Clearly Audible
NCA03	747032	"109-113 GEORGE ST, PARRAMATTA"	22	RES	68	63	58	48			62	69		0	0	4	14	-	4	None	None	Noticable	Clearly Audible
NCA03	747031	"109-113 GEORGE ST, PARRAMATTA"	21	RES	68	63	58	48			64	72		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	747030	"109-113 GEORGE ST, PARRAMATTA"	20	RES	68	63	58	48			64	72		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	747029	"109-113 GEORGE ST, PARRAMATTA"	19	RES	68	63	58	48			64	72		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	747028	"109-113 GEORGE ST, PARRAMATTA"	18	RES	68	63	58	48			63	71		0	0	5	15	-	5	None	Noticable	Noticable	Clearly Audible
NCA03	747027	"109-113 GEORGE ST, PARRAMATTA"	17	RES	68	63	58	48			63	71		0	0	5	15	-	5	None	Noticable	Noticable	Clearly Audible
NCA03	747026	"109-113 GEORGE ST, PARRAMATTA"	16	RES	68	63	58	48			63	71		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	747025	"109-113 GEORGE ST, PARRAMATTA"	15	RES	68	63	58	48			63	70		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	747024	"109-113 GEORGE ST, PARRAMATTA"	14	RES	68	63	58	48			63	70		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	747023	"109-113 GEORGE ST, PARRAMATTA"	13	RES	68	63	58	48			63	70		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	747022	"109-113 GEORGE ST, PARRAMATTA"	12	RES	68	63	58	48			63	70		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	747021	"109-113 GEORGE ST, PARRAMATTA"	11	RES	68	63	58	48			63	70		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	747020	"109-113 GEORGE ST, PARRAMATTA"	10	RES	68	63	58	48			63	70		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	747019	"109-113 GEORGE ST, PARRAMATTA"	9	RES	68	63	58	48			63	71		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	747018	"109-113 GEORGE ST, PARRAMATTA"	8	RES	68	63	58	48			63	71		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	747017	"109-113 GEORGE ST, PARRAMATTA"	7	RES	68	63	58	48			63	70		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	747016	"109-113 GEORGE ST, PARRAMATTA"	6	RES	68	63	58	48			60	67		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	747015	"109-113 GEORGE ST, PARRAMATTA"	5	RES	68	63	58	48			59	67		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	747014	"109-113 GEORGE ST, PARRAMATTA"	4	RES	68	63	58	48			59	66		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	746692	"91 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746691	"91 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			75	83	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746690	"91 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			76	84	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746689	"91 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			77	84	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746688	"91 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			78	85	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746687	"91 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			79	86	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746686	"91 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			80	87	Y	10	10	10	10	-	10	Noticable	Noticable	Noticable	Noticable
NCA03	746685	"91 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			81	88	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746684	"91 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			81	89	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746683	"91 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			82	90	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746560	"SE 2 LEVEL 2 107 GEORGE ST, PARRAMATTA"	4	RES	68	63	58	48			66	73		0	3	8	18	-	8	None	Noticable	Noticable	Clearly Audible
NCA03	746559	"SE 2 LEVEL 2 107 GEORGE ST, PARRAMATTA"	3	RES	68	63	58	48			65	73		0	2	7	17	-	7	None	Noticable	Noticable	Clearly Audible

NCA03	746558	"SE 2 LEVEL 2 107 GEORGE ST, PARRAMATTA"	2	RES	68	63	58	48			64	72		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	746557	"SE 2 LEVEL 2 107 GEORGE ST, PARRAMATTA"	1	RES	68	63	58	48			63	71		0	0	5	15	-	5	None	Noticable	Noticable	Clearly Audible
NCA03	746350	"6-10 CHARLES ST, PA"	16	RES	68	63	58	48			58	66		0	0	0	10	-	0	None	None	Noticable	Clearly Audible
NCA03	746349	"6-10 CHARLES ST, PA"	15	RES	68	63	58	48			58	66		0	0	0	10	-	0	None	None	Noticable	Clearly Audible
NCA03	746173	"150 GEORGE ST, PARRAMATTA"	15	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746172	"150 GEORGE ST, PARRAMATTA"	14	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746171	"150 GEORGE ST, PARRAMATTA"	13	COM	70	70	70	70			73	81		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746170	"150 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746169	"150 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746168	"150 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			75	82		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746167	"150 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			75	83	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746166	"150 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			76	84	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746165	"150 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			77	84	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746164	"150 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			77	85	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746163	"150 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			78	86	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746162	"150 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			79	87	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746161	"150 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			80	88	Y	10	10	10	10	-	10	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746160	"150 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			82	89	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746159	"150 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			82	90	Y	12	12	12	12	-	12	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746150	"150 GEORGE ST, PARRAMATTA"	19	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	746149	"150 GEORGE ST, PARRAMATTA"	18	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746148	"150 GEORGE ST, PARRAMATTA"	17	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746147	"150 GEORGE ST, PARRAMATTA"	16	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746113	"140 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			81	88	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746012	"95-101 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			73	81		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746011	"95-101 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			74	81		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746010	"95-101 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			75	82		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746009	"95-101 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			76	83	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746008	"95-101 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			77	84	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746007	"95-101 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			78	86	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746006	"95-101 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			79	87	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746005	"95-101 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			81	89	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746004	"95-101 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			84	91	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746003	"95-101 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			86	94	Y	16	16	16	16	-	16	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746002	"95-101 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			88	96	Y	18	18	18	18	-	18	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746001	"95-101 GEORGE ST, PARRAMATTA"	16	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable

NCA03	746000	"95-101 GEORGE ST, PARRAMATTA"	15	COM	70	70	70	70			71	78		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745999	"95-101 GEORGE ST, PARRAMATTA"	14	COM	70	70	70	70			71	79		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745998	"95-101 GEORGE ST, PARRAMATTA"	13	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745997	"95-101 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			72	80		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745800	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	18	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745799	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	17	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745798	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	16	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745797	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	15	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745796	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	14	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745795	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	13	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745794	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	12	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745793	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	11	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745792	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	10	EDU	55	55	55	55			60	68		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745791	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	9	EDU	55	55	55	55			60	67		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745790	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	8	EDU	55	55	55	55			59	67		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745789	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	7	EDU	55	55	55	55			59	66		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745788	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	6	EDU	55	55	55	55			58	66		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745787	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	5	EDU	55	55	55	55			58	65		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745786	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	4	EDU	55	55	55	55			57	65		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745785	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	3	EDU	55	55	55	55			57	64		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745784	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	2	EDU	55	55	55	55			55	63		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745596	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			73	81		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745595	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			74	82		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745594	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			75	82		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	745593	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			76	84	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745592	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			77	85	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	745591	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			79	86	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	745590	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			80	88	Y	10	10	10	10	-	10	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745589	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			83	90	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745588	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			86	93	Y	16	16	16	16	-	16	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745587	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			89	96	Y	19	19	19	19	-	19	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745130	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	10	RES	68	63	58	48			64	71		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	745129	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	9	RES	68	63	58	48			64	71		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	745128	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	8	RES	68	63	58	48			64	71		0	1	6	16	-	6	None	Noticable	Noticable	Clearly Audible
NCA03	745127	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	7	RES	68	63	58	48			63	71		0	0	5	15	-	5	None	Noticable	Noticable	Clearly Audible
NCA03	745126	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	6	RES	68	63	58	48			63	70		0	0	5	15	-	5	None	None	Noticable	Clearly Audible

NCA03	745125	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	5	RES	68	63	58	48			62	70		0	0	4	14	-	4	None	None	Noticable	Clearly Audible
NCA03	745124	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	4	RES	68	63	58	48			62	69		0	0	4	14	-	4	None	None	Noticable	Clearly Audible
NCA03	745123	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	3	RES	68	63	58	48			61	69		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	745122	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	2	RES	68	63	58	48			61	68		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	745121	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	1	RES	68	63	58	48			60	68		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	744949	"30 CHARLES ST, PARRAMATTA"	11	RES	68	63	58	48			73	81		5	10	15	25	-	15	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744948	"30 CHARLES ST, PARRAMATTA"	10	RES	68	63	58	48			74	81		6	11	16	26	-	16	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744947	"30 CHARLES ST, PARRAMATTA"	9	RES	68	63	58	48			74	82		6	11	16	26	-	16	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744946	"30 CHARLES ST, PARRAMATTA"	8	RES	68	63	58	48			75	83	Y	7	12	17	27	-	17	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744945	"30 CHARLES ST, PARRAMATTA"	7	RES	68	63	58	48			76	83	Y	8	13	18	28	-	18	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744944	"30 CHARLES ST, PARRAMATTA"	6	RES	68	63	58	48			77	84	Y	9	14	19	29	-	19	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744943	"30 CHARLES ST, PARRAMATTA"	5	RES	68	63	58	48			77	85	Y	9	14	19	29	-	19	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744942	"30 CHARLES ST, PARRAMATTA"	4	RES	68	63	58	48			78	86	Y	10	15	20	30	-	20	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744941	"30 CHARLES ST, PARRAMATTA"	3	RES	68	63	58	48			79	86	Y	11	16	21	31	-	21	Clearly Audible	Clearly Audible	Moderately Intrusive	Highly Intrusive
NCA03	744940	"30 CHARLES ST, PARRAMATTA"	2	RES	68	63	58	48			79	87	Y	11	16	21	31	-	21	Clearly Audible	Clearly Audible	Moderately Intrusive	Highly Intrusive
NCA03	744939	"30 CHARLES ST, PARRAMATTA"	1	RES	68	63	58	48			79	87	Y	11	16	21	31	-	21	Clearly Audible	Clearly Audible	Moderately Intrusive	Highly Intrusive
NCA03	744938	"30 CHARLES ST, PARRAMATTA"	14	RES	68	63	58	48			71	79		3	8	13	23	-	13	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744937	"30 CHARLES ST, PARRAMATTA"	13	RES	68	63	58	48			72	80		4	9	14	24	-	14	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744936	"30 CHARLES ST, PARRAMATTA"	12	RES	68	63	58	48			73	80		5	10	15	25	-	15	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744903	"22 CHARLES ST, PARRAMATTA"	2	RES	68	63	58	48			77	84	Y	9	14	19	29	-	19	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744902	"22 CHARLES ST, PARRAMATTA"	1	RES	68	63	58	48			77	84	Y	9	14	19	29	-	19	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744901	"22 CHARLES ST, PARRAMATTA"	4	RES	68	63	58	48			76	83	Y	8	13	18	28	-	18	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744900	"22 CHARLES ST, PARRAMATTA"	3	RES	68	63	58	48			76	84	Y	8	13	18	28	-	18	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744899	"22 CHARLES ST, PARRAMATTA"	10	RES	68	63	58	48			73	80		5	10	15	25	-	15	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744898	"22 CHARLES ST, PARRAMATTA"	9	RES	68	63	58	48			73	81		5	10	15	25	-	15	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744897	"22 CHARLES ST, PARRAMATTA"	8	RES	68	63	58	48			74	81		6	11	16	26	-	16	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744896	"22 CHARLES ST, PARRAMATTA"	7	RES	68	63	58	48			74	82		6	11	16	26	-	16	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744895	"22 CHARLES ST, PARRAMATTA"	6	RES	68	63	58	48			75	82		7	12	17	27	-	17	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744894	"22 CHARLES ST, PARRAMATTA"	5	RES	68	63	58	48			75	83	Y	7	12	17	27	-	17	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744376	"89 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			72	79		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	744375	"89 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			70	78		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable

C.2 Vibration

NCA	Receiver	Address	Land use	Vibration Impact

George St Water Discharge Route			
Project	SMW WTP - Westmead and Parramatta		
Client	Gamuda Laing O'Rourke Consortium		
Assessment Date	02/03/2023	Assessment Id	PARRA-036
Proposed start date	26/06/2023	Proposed end date	01/07/2023

Contents

Acoustic terms and acronyms

AA	Acoustic Advisor
AMM	Additional mitigation measures – applicable where standard measures have been implemented and NML is still expected to be exceeded.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
ICNG	Interim Construction Noise Guideline (Department of Environment and Climate Change 2009)
NCA	Noise Catchment Area
Noise level statistics	L_{A90} - The A-weighted sound pressure level exceeded 90% of the monitoring period. This is considered to represent the background noise. L_{Aeq} - The equivalent continuous A-weighted noise level—the level of noise equivalent to the energy average of noise levels occurring over a measurement period. L_{A1} – The A-weighted sound pressure level exceeded 1% of the monitoring period. L_{Amax} – The maximum A-weighted noise level associated with the measurement period.
NML	Noise Management Level
PPV	Peak Particle Velocity – Measurement of ground-borne vibration in units of mm/s
RBL	Rating Background Level - a single figure that represents the background noise level for assessment purposes
ROL	Road Occupancy Licence – granted by Transport for NSW and required for any activity likely to impact on traffic flow.
SWL	Sound Power Level - The A-weighted sound power level is a logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
SPL	Sound pressure level - This is the level of noise, usually expressed in dB(A), as measured by a standard sound level meter with a pressure microphone. The sound pressure level in dB(A) gives a close indication of the subjective loudness of noise. A technical definition for the sound pressure level, in decibels, is 20 times the logarithm (base 10) of the ratio of any two quantities related to a given sound pressure to a reference pressure (typically 20 µPa equivalent to 0 dB).
Tonal noise	Noise with perceptible and definite pitch or tone
VDV	Vibration dose value – used when assessing intermittent vibration as it is sensitive to peaks in vibration acceleration and accumulates the vibration energy received over the daytime and night-time periods

1 Introduction

1.1 Overview

The Sydney Metro Western Tunnelling Package is being delivered by the Gamuda Australia and Laing O'Rourke Consortium (GLC) and includes twin nine-kilometre tunnels between Sydney Olympic Park and Westmead, excavation of two new metro stations, and a stabling and maintenance facility at Clyde (the Project).

During the Project, there is potential for nearby sensitive receivers to experience adverse impacts relating to noise and vibration. The project's Noise and Vibration Management Sub Plan (NVMP) was developed to satisfy the project's Conditions of Approval (CoA) and addresses the assessment and management of noise and vibration impacts during construction.

Under the NVMP, KNOWnoise™, a project-specific noise prediction tool, has been developed to prepare a Construction noise and vibration impact statement (CNIS) for site and activity-specific noise works and provide ongoing risk analysis during project delivery and for when out-of-hours work is proposed (as per the Project's out-of-hours protocol).

This CNIS has been prepared using KNOWnoise™ and addresses activities for construction of the Westmead and Parramatta station boxes and utilities corridor between the two sites, as illustrated in Figure 1.

The structure of this CNIS includes:

- Section 1.2 – Construction works and hours with justification for these works in Section 1.3
- Section 2 – Existing environment
- Section 3 – Assessment framework including noise and vibration management levels
- Section 4 – Construction noise assessment
- Section 5 – Mitigation and management, including consultation

1.2 Planned works

GLC plans to carry out the works described in Appendix A, which lists each assessed activity, its timing and proposed equipment.

1.3 Justification of the works

In line with the Interim Construction Noise Guidelines (DECC 2009), justification is typically required to work outside approved construction hours. These situations may involve low impact or emergency works and works under an out-of-hours work protocol.

GLC proposes the works subject to this assessment outside approved construction hours for the following reason.

- Works are required to be completed outside of standard construction hours as (a) the applicable council permits and Road Occupancy License (ROL) for access to the footpaths and road network will only be issued for non-peak periods (i.e. weekend, evening and night works) along Smith Street; and (b) works are required to be completed without obstructing access to the public and adjacent commercial premises).

Figure 1 Location map

1 Existing environment

1.1 Sensitive receivers

The Westmead study area is centred on the Westmead metro station construction site. The construction site is located to the south of the existing Westmead Station and is bound by Hawkesbury Road to the west, Hassall Street to the east and Baily Street to the south.

Existing noise levels in this study area are generally controlled by transportation noise from the surrounding road network and existing rail line. The area surrounding the construction site is generally suburban and the nearest receivers are residential.

The Parramatta study area is centred on the Parramatta metro station construction site. The construction site is located between George Street and Macquarie Street, and between Church Street and Smith Street.

Existing noise levels in this study area are controlled by road traffic noise and general urban hum associated with the CBD. As with any CBD, existing noise levels and are relatively high during the daytime, evening and night-time. The area surrounding the construction site is mainly commercial and the nearest receivers are close to the boundary of the site. The nearest receivers are typically of general office or retail use.

1.2 Noise catchment areas

To facilitate the assessment of noise impacts from the project and to apply representative Noise Management Levels (NMLs) to all receivers, receivers adjacent to the Westmead and Parramatta sites have been divided into Noise Catchment Areas (NCAs). The Westmead site contains two noise catchments (NCA01 and NCA02) and NCA03 comprises the Parramatta CBD.

NCAs group individual sensitive receivers by representative traits such as existing noise environment and potential exposure to noise and vibration from the Project.

NCAs established as part of the EIS are summarised in Table 1 and illustrated in Figure 1. Background noise monitoring has been completed as part of the EIS to apply appropriate NML to each NCA.

Table 1 Summary of work areas, Noise Catchment Areas and land uses

NCA	Location	Description
1	Westmead	North of the existing rail corridor in Westmead and mainly residential. 'Other sensitive' receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.
2		South of the existing rail corridor and mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.
3	Parramatta	Covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many 'other sensitive' receivers in this catchment, including Western Sydney University, Arthur Phillip High School, Parramatta Public School, and a number of hotels and places of worship.

2 Assessment framework

2.1 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2. Use of power saws, rock breakers, drills and other tonal or impulsive activities are defined as annoying under the Interim Construction Noise Guideline (ICNG) and are 'highly noise intensive works'.

Table 2 Approved construction hours

CoA	Construction activity	Monday to Friday	Saturday	Sunday / Public holiday
D35	Approved construction	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work (unless approved under EPL or out-of-hours work protocol)
D36	Highly noise intensive works	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work (unless approved under EPL or out-of-hours work protocol)

Notes:

1. if continuously, then not exceeding three hours, with a minimum cessation of work of not less than one hour.

2.2 Noise assessment criteria

2.2.1 Construction noise

The ICNG describes noise in excess of the background level as potentially having an adverse impact on sensitive receivers and increasing the likelihood of complaint. During standard construction hours, where construction noise is within 10 dB(A) of the RBL, impacts would be acceptable.

Where construction noise is more than 10 dB(A) above the RBL during standard construction hours, a residential receiver is considered noise affected and the proponent should undertake all reasonable and feasible steps necessary to manage the impact and consult with the affected community.

Above a $L_{Aeq,\ 15\ minute}$ noise level of 75 dB(A), a receiver is highly affected, requiring consideration of additional mitigation measures including alternative accommodation in the night period.

Outside standard construction hours, construction noise at a residential receiver more than 5 dB(A) above the RBL is taken to be noise affected. Table 1 (reproduced from Table 2 of the ICNG) sets out the NMLs for residences and how they are to be applied.

In addition, annoying noise such as rock hammers, impact piling, or other impulsive noise sources usually result in greater annoyance than continuous construction noise. A 5 dB(A) penalty is applicable to such activities prior to comparison with the NMLs.

2.2.2 Sleep disturbance

The CNVS requires maximum noise levels to be analysed in terms of the extent and number of times the maximum noise exceeds specific noise trigger levels, in general accordance with the Noise Policy for Industry (NPfI) (EPA 2017). These triggers are:

- LAeq, 15 minute 40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and the
- LAmax 52 dBA or the prevailing RBL plus 15 dB, whichever is greater.

The NPfI also recommends the DECCW (2011) Road Noise Policy (RNP) be reviewed for further risk assessment. The RNP recommends maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep and one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

Table 3 Residential noise management levels

Time of day	NML $L_{Aeq\ (15\ min)}$ *	How to apply
Standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Other sensitive land uses, such as schools and offices, typically find noise from construction disruptive when the properties are being used (such as during work and school times). The noise management levels for non-residential receivers set in accordance with the Interim Construction Noise Guideline are provided in Table 4. These levels apply only during hours when the non-residential premises are being used.

The difference between an internal noise level and the external noise level is about 10 dB(A), which provides a conservative assumption that windows are open for ventilation. Buildings where windows are fixed or cannot otherwise be opened may achieve a greater noise level performance.

Table 4 Non-residential sensitive land uses noise management levels

Land use	Noise assessment location	NML ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Places of worship		
Active recreation areas (such as sporting activities and activities which generate their own noise or focus for participants)	External	65
Passive recreation areas (contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External	60
Industrial premises	External	75
Office, retail outlets	External	70

2.3 Project construction noise management levels

The Project specific construction noise management levels for residential receivers have been established in line with the ICNG, based on the RBLs relevant to each NCA. These are presented in Table 5. NMLs for non-residential sensitive receivers are described in Table 4.

Table 5 Project specific construction NMLs

NCA	Noise Management Level, $L_{Aeq\ 15\ minute}$						
	Approved hours		Outside approved hours				
	Noise affected	Highly noise affected	Day	Evening	Night	Sleep disturbance (CNVS)	
						$L_{Aeq,\ 15\ minute}$	L_{Amax}
1	58	75	53	51	46	46	56
2	59	75	54	52	42	42	52
3	68	75	63	58	48	48	58

As part of planning for out of hours works, standard mitigation measures, as described in the CNVMP, are implemented where reasonable and feasible. However, after these measures have been applied, noise and vibration levels may continue to exceed the NMLs.

In this case, additional mitigation measures outlined in the CNVS, which largely focus on engagement with affected sensitive receivers, should be implemented where reasonable and feasible, unless other agreements are in place with the impacted receiver.

Triggers and additional mitigation measures for airborne noise are taken from the Project's OOHW Protocol and summarised in Table 6. Further details of specific additional mitigation measures are described in the CNVS.

Table 6 Triggers for additional mitigation measures – Airborne noise (Sydney Metro 2020)

Construction hours	Class	dB above NML	Additional management measures
Approved hours Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	N	0 to 10	-
	CA	10 to 20	LB
	MI	20 to 30	LB, M, SN
	HI	>30	LB, M, SN
Evening Monday – Friday: 6pm – 10pm Saturday: 7am – 8am, 6pm – 10pm Sunday / PH: 8am – 6pm	N	0 to 10	LB
	CA	10 to 20	LB, M
	MI	20 to 30	LB, M, SN, RO
	HI	> 30	LB, M, SN, IB, PC, RO
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am) Sunday / PH: 6pm –7am	N	0 to 10	LB
	CA	10 to 20	LB, M, SN, RO
	MI	20 to 30	LB, M, SN, IB, PC, RO, AA
	HI	> 30	LB, M, SN, IB, PC, RO, AA

Notes: PC = Phone Calls and emails
M = Monitoring
IB = Individual briefings
AA = Alternative accommodation
SN = Specific notification
LB = Letterbox drops
RO = Project specific respite offer

N = Noticeable CA = Clearly audible MI Moderately intrusive HI = Highly intrusive

2.4 Vibration management

2.4.1 Human comfort

When assessing human exposure to construction-related vibration, the CNVS requires vibration goals to be established using *Environmental Noise Management Assessing Vibration: A Technical Guideline* (DECC 2006), which provides criteria for the assessment of vibration impacts on humans.

Construction activities typically generate vibration of an intermittent nature, which is assessed using a Vibration Dose Value (VDV). Acceptable values of vibration doses are presented in Table 7 for sensitive receivers.

Table 7 VDV Vibration criteria

Receiver type	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings – 16 hour day (7am to 11pm)[1]	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings – 8 hour night (11pm to 7am)[1]	0.13	0.26	0.51

Note 1: Day time and night time as described in BS6472:1992 (as referenced in the CNVS), i.e. a daytime period of 16 h or a night time period of 8 h, for example 23.00 h to 07.00 h.

2.4.2 Buildings

Potential building damage from construction vibration requires the application of values in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings* Part 2. These values are presented in Table 8 and relate to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Table 8 Guideline values for vibration velocity for the effects of short-term vibration on structures (BS 7385).

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz to 50 mm/s at 40 Hz and above

Where vibration may give rise to magnification due to resonance, especially at lower frequencies where lower guide values apply, the guide values may be reduced by 50%. The CNVS describes rock breaking/hammering and sheet piling activities as having potential to cause dynamic loading in some structures (e.g. residences).

For activity involving rock breakers, piling rigs, vibratory rollers, excavators, vibration predominantly occurs at frequencies in the 10 Hz to 100 Hz range. On this basis, a conservative vibration damage screening level is:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

2.4.3 Heritage

Heritage buildings and structures would be assessed under a conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150). Where vibration levels at heritage items are identified as exceeding this screening level, structural assessment would be completed by the Project team to confirm the structure's sensitivity to vibration. If a heritage building or structure is found to be structurally unsound (following inspection) the conservative criterion would stand. Where the structure is suitably sound, the guideline values from Table 8 would be applicable.

2.4.4 Additional mitigation measures

The CNVS recommends additional mitigation measures where all standard mitigation measures to minimise vibration at the nearest receivers have been implemented and vibration is still predicted to exceed the maximum guideline values. The Additional Mitigation Measures Matrix (AMMM) for vibration from the CNVS is presented in Table 9.

Table 9 Additional Vibration Mitigation Measures (CNVS)

Construction hours	Mitigation measures where predicted vibration levels exceed maximum levels
Approved hours Monday – Friday: 7am – 6pm, Saturday: 8am to 6pm	LB, M, RO
Evening Monday – Friday: 6pm – 10pm; Saturday: 7am – 8am, 6pm – 10pm; Sunday / PH: 8am – 6pm	LB, M, IB, PC, RO, SN
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am); Sunday / PH: 6pm –7am	LB, M, IB, PC, RO, SN, AA

3 Impact assessment

3.1 Modelling method

Predictions of noise impacts were performed using KNOWnoise™, a project-specific noise assessment tool developed by Hutchison Weller for the CTP Project. KNOWnoise calculates the maximum $L_{Aeq,15minute}$ noise level for each identified receiver for each proposed activity using predictions from SoundPlan noise modelling software. Predictions include geometric spreading, air and ground absorptions as well as topographical and structural screening and reflection.

The following components were incorporated in the model:

- Topography – Based on terrain data of 1 m resolution.
- Individual sensitive receivers – Worst-affected façade of each building to 700 metres from the works
- Construction noise sources –Activities and equipment provided by GLC were included in the noise model as individual sources across the nominated work areas for each activity. The maximum predicted LAeq noise level within each work area was identified for each receiver.
- Cumulative impacts – all activities with overlapping time periods are included in cumulative results
- Source height – construction noise sources assumed to be at 1.5 metres above ground level.
- Ground Absorption – Ground assumed to be mixed hard and soft with absorption factor of 0.5
- Meteorology –worst-case meteorological conditions (gentle breeze from source to receiver and stable conditions).
- Residential building structures are included in the model, meaning screening provided by neighboring houses is considered.
- Results are shown for all floors of assessed buildings with the worst-case façade result assumed for the whole floor.

Equipment proposed to be used for OOHW activities together with estimated sound power levels for each item are summarised in Appendix A.

The sound power levels and ultimate predicted noise levels will depend on the number of plant items operating at any one time and their precise location relative to a sensitive receiver. In practice, the predicted levels will vary due to plant moving around the site and not operating intensively or concurrently for a 15 minute assessment period. Shielding and reflection provided by buildings will also vary as plant moves around the site. Therefore, predicted noise levels are conservative.

3.2 Predicted noise levels

Predicted impact classes for the Evening period are illustrated graphically in Appendix B. Each identified receiver in the study area has been coloured to highlight the predicted level of impact.

Detailed predicted noise levels for each potentially affected receiver are presented Appendix C.

Table 10 presents the worst-case predicted noise level of 86 dB(A) during the works, resulting in 26 receivers classed as highly noise affected.

Table 10 Summary of maximum predicted noise level and highly affected receivers for the Evening period.

Maximum cumulative predicted $L_{Aeq,\ 15\ minute}$ noise level	86 dB(A)
Number of highly noise affected receivers (>75 dB)	26

With reference to the CNVS, the number of senstive receivers classified in each impact class for each assessment period are summarised in the following tables.

Table 11 Summary of NML exceedance ranges for standard hours.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	77
Clearly Audible	10 <= 20 dB above NML	5
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 12 Summary of NML exceedance ranges for outside standard hours - weekend.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	68
Clearly Audible	10 <= 20 dB above NML	14
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 13 Summary of NML exceedance ranges for outside standard hours - evenings.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	81
Clearly Audible	10 <= 20 dB above NML	29

Impact class	Predicted noise level	Predicted number of receivers
Moderately Intrusive	20 <= 30 dB above NML	0
Highly Intrusive	> 30 dB above NML	0

Table 14 Summary of NML exceedance ranges for outside standard hours - nights.

Impact class	Predicted noise level	Predicted number of receivers
Noticable	0 <= 10 dB above NML	87
Clearly Audible	10 <= 20 dB above NML	33
Moderately Intrusive	20 <= 30 dB above NML	24
Highly Intrusive	> 30 dB above NML	0

In the event works are planned for more than two consecutive nights, sleep disturbance has been considered. Table 15 summarises the number of residents predicted to exceed the sleep disturbance screening criterion. Further analysis is also provided to indicate the number of receivers expected to be woken, at LAmax noise levels greater than 65 dBA.

Where exceedances of the awakening criteria are predicted, additional care should be taken, and mitigation measures implemented in line with the CNVS.

Table 15 Summary of predicted exceedances of sleep disturbance screening criterion and awakening criterion.

Criterion	Predicted number of receivers
Potentially Sleep Disturbed (exceed RBL + 15 screening criterion)	0
Exceed 65 dBA awakening criterion	0

3.3 Vibration

The CNVS requires attended vibration measurements at commencement of vibration generating activities to confirm vibration levels satisfy the criteria for that activity.

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. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

Based on the proposed work locations and selected equipment, indicative exceedances of the vibration criteria are summarised in Table 16. The exceedances are based on recommended minimum working distances from vibration intensive plant given in Appendix D of the Construction Noise and Vibration Strategy (Transport for NSW 2019). Vibration impacts for each sensitive receiver are listed in Appendix C.

Table 16 Predicted exceedances of vibration criteria

Impact classification	Number of potentially affected receivers
Human comfort	18
Cosmetic damage	3
Heritage structure	0

4 Controls and safeguards

The Project represents a risk of adverse impacts on sensitive receivers, particularly when working close to the project boundary and outside approved hours.

Where short term noise impacts are unavoidable, mitigation measures described in the project construction environment management plan should be implemented together with the recommendations in in Table 14.

Table 17 and additional mitigation measures for each receiver identified in Appendix B and summarised in Table 14.

Table 17 Standard mitigation measures

Community consultation	• Potentially affected receivers will be notified of OOH works in accordance with project requirements. • Where practicable, works will be scheduled to not conflict with major student examination periods, church congregation times, and other sensitive periods identified through community consultation.
Site induction	• All workers will be inducted to the project prior to commencing work and will be cognisant of their noise and vibration obligations under the CNVMP.
Behavioural practices	• Avoid swearing and unnecessary shouting or loud radios onsite. • Avoid dropping materials from height.
Equipment selection	• Priority given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable. • The noise levels of plant and equipment would meet the maximum noise requirements of the CNVS.
Use and siting of plant	• Locate compounds away from sensitive receivers and discourage access from local roads. • Plant used intermittently to be throttled down or shut down. • Noise-emitting plant to be directed away from sensitive receivers where possible. • Stationary plant should be located behind a structure or enclosed if practicable. • Deliveries should be made as far as practical from sensitive receivers. Dedicated loading/unloading sites should be shielded where possible, if close to receivers. • Plan traffic flow, parking and loading/unloading areas to minimise reversing. • Avoid compression breaking on approach to the site. • Where additional activities or plant may result in marginal noise increases and speed works up, consider concentrating activities at one location and complete works as quickly as possible.
Non-tonal reversing alarms.	• Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Noise monitoring	• Monitoring should be completed to verify the assumptions of this CNVIS regarding estimated equipment noise emissions and to ensure compliance with the CNVS.
Vibration monitoring	• Attended vibration measurements should be completed at commencement of vibration generating activities predicted to occur within safe working distances for cosmetic damage. • Where monitoring demonstrates maximum levels exceeded, consider alternative methodologies/equipment
Implement any project specific mitigation measures	
1	Mitigation mesasures as per Project NVMP & DNVIS.

Table 18 Additional mitigation measures

Code	Measure	Description
AA	Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.
M	Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, 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 receiver have 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 has been exceeded so that additional management measures may be implemented.
IB	Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
LB	Letterbox drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.
RO	Respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.
PC	Phone calls	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Appendix A Proposed activities and associated sound power levels

Section 4 - Stage 3 - Installation of Pipeline & Reinstate Surface
Installation of pipeline, backfill excavations, compact and reinstate surface with asphalt.
26/06/2023 8:00:08 PM - 01/07/2023 5:00:19 AM

Equipment	Quantity	Usage	Reduction	SWL
Bogies	1	30 %	0	95
Plate compactor (small e.g. 60kg)	1	30 %	0	99
Tipper Truck	1	30 %	0	93
Daymakers / Lighting plant	1	100 %	0	93
Light vehicle	1	10 %	0	75
Diamond core drill (e.g Hilti DD150)	1	10 %	0	105

Activity Sound Power Level: 107
* includes 5 dB penalty for potentially annoying characteristics in line with the ICNG

Appendix B Map showing predicted noise impacts by impact class

Appendix C Detailed predictions

C.1 Noise

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Construction noise impact statement

Assessment: George St Water Discharge Route					NML, LAeq, 15 minute				Sleep, LAmax		Predicted noise level, dBA		Exceedance summary										
														Exceed NML by (dB):				Exceed sleep disturbance by (dB):		Impact classification			
NCA	Rec	Address	Flr	Land use	Day	O/day	Eve	Night	Screen	Awake	Cumulative LAeq, 15 minute	LMax	Highly Affected?	Day	O/day	Eve	Night	Screen	Awake	Day	O/day	Eve	Night
NCA03	747032	"109-113 GEORGE ST, PARRAMATTA"	22	RES	68	63	58	48			59	68		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	747031	"109-113 GEORGE ST, PARRAMATTA"	21	RES	68	63	58	48			61	71		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	747030	"109-113 GEORGE ST, PARRAMATTA"	20	RES	68	63	58	48			62	71		0	0	4	14	-	4	None	None	Noticable	Clearly Audible
NCA03	747029	"109-113 GEORGE ST, PARRAMATTA"	19	RES	68	63	58	48			62	71		0	0	4	14	-	4	None	None	Noticable	Clearly Audible
NCA03	747028	"109-113 GEORGE ST, PARRAMATTA"	18	RES	68	63	58	48			60	70		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	747027	"109-113 GEORGE ST, PARRAMATTA"	17	RES	68	63	58	48			61	70		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	747026	"109-113 GEORGE ST, PARRAMATTA"	16	RES	68	63	58	48			60	70		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	747025	"109-113 GEORGE ST, PARRAMATTA"	15	RES	68	63	58	48			60	69		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	747024	"109-113 GEORGE ST, PARRAMATTA"	14	RES	68	63	58	48			60	69		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	747023	"109-113 GEORGE ST, PARRAMATTA"	13	RES	68	63	58	48			60	69		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	747022	"109-113 GEORGE ST, PARRAMATTA"	12	RES	68	63	58	48			60	69		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	747021	"109-113 GEORGE ST, PARRAMATTA"	11	RES	68	63	58	48			60	69		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	747020	"109-113 GEORGE ST, PARRAMATTA"	10	RES	68	63	58	48			60	69		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	747019	"109-113 GEORGE ST, PARRAMATTA"	9	RES	68	63	58	48			60	70		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	747018	"109-113 GEORGE ST, PARRAMATTA"	8	RES	68	63	58	48			60	70		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	747017	"109-113 GEORGE ST, PARRAMATTA"	7	RES	68	63	58	48			60	69		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	746692	"91 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			72	81		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746691	"91 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			72	82		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746690	"91 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			73	83		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746689	"91 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			74	83		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746688	"91 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			75	84		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746687	"91 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			76	85	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746686	"91 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			77	86	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746685	"91 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			78	87	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746684	"91 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			79	88	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746683	"91 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			79	89	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746560	"SE 2 LEVEL 2 107 GEORGE ST, PARRAMATTA"	4	RES	68	63	58	48			63	72		0	0	5	15	-	5	None	None	Noticable	Clearly Audible
NCA03	746559	"SE 2 LEVEL 2 107 GEORGE ST, PARRAMATTA"	3	RES	68	63	58	48			62	72		0	0	4	14	-	4	None	None	Noticable	Clearly Audible
NCA03	746558	"SE 2 LEVEL 2 107 GEORGE ST, PARRAMATTA"	2	RES	68	63	58	48			61	71		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	746557	"SE 2 LEVEL 2 107 GEORGE ST, PARRAMATTA"	1	RES	68	63	58	48			60	70		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	746171	"150 GEORGE ST, PARRAMATTA"	13	COM	70	70	70	70			70	80		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	746170	"150 GEORGE ST, PARRAMATTA"	12	COM	70	70	70	70			71	80		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746169	"150 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			71	81		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable

NCA03	746168	"150 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			72	81		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746167	"150 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			73	82		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746166	"150 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			73	83		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746165	"150 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			74	83		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746164	"150 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			75	84		5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746163	"150 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			75	85	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746162	"150 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			76	86	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	746161	"150 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			78	87	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746160	"150 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			79	88	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746159	"150 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			80	89	Y	10	10	10	10	-	10	Noticable	Noticable	Noticable	Noticable
NCA03	746113	"140 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			78	87	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	746012	"95-101 GEORGE ST, PARRAMATTA"	11	COM	70	70	70	70			70	80		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	746011	"95-101 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			71	80		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	746010	"95-101 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			72	81		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	746009	"95-101 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			73	82		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	746008	"95-101 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			74	83		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	746007	"95-101 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			75	85	Y	5	5	5	5	-	5	Noticable	Noticable	Noticable	Noticable
NCA03	746006	"95-101 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			77	86	Y	7	7	7	7	-	7	Noticable	Noticable	Noticable	Noticable
NCA03	746005	"95-101 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			79	88	Y	9	9	9	9	-	9	Noticable	Noticable	Noticable	Noticable
NCA03	746004	"95-101 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			81	90	Y	11	11	11	11	-	11	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746003	"95-101 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			84	93	Y	14	14	14	14	-	14	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	746002	"95-101 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			85	95	Y	15	15	15	15	-	15	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745800	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	18	EDU	55	55	55	55			57	67		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745799	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	17	EDU	55	55	55	55			57	67		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745798	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	16	EDU	55	55	55	55			57	67		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745797	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	15	EDU	55	55	55	55			57	67		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745796	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	14	EDU	55	55	55	55			57	67		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745795	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	13	EDU	55	55	55	55			57	67		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745794	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	12	EDU	55	55	55	55			57	67		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745793	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	11	EDU	55	55	55	55			57	67		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745792	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	10	EDU	55	55	55	55			57	67		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745791	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	9	EDU	55	55	55	55			57	66		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745790	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	8	EDU	55	55	55	55			56	66		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745789	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	7	EDU	55	55	55	55			56	65		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745788	ARTHUR PHILIP HIGH SCHOOL 80-100 MACQUAR	6	EDU	55	55	55	55			55	65		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable
NCA03	745596	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	10	COM	70	70	70	70			70	80		0	0	0	0	-	0	Noticable	Noticable	Noticable	Noticable

NCA03	745595	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	9	COM	70	70	70	70			71	81		1	1	1	1	-	1	Noticable	Noticable	Noticable	Noticable
NCA03	745594	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	8	COM	70	70	70	70			72	81		2	2	2	2	-	2	Noticable	Noticable	Noticable	Noticable
NCA03	745593	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	7	COM	70	70	70	70			73	83		3	3	3	3	-	3	Noticable	Noticable	Noticable	Noticable
NCA03	745592	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	6	COM	70	70	70	70			74	84		4	4	4	4	-	4	Noticable	Noticable	Noticable	Noticable
NCA03	745591	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	5	COM	70	70	70	70			76	85	Y	6	6	6	6	-	6	Noticable	Noticable	Noticable	Noticable
NCA03	745590	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	4	COM	70	70	70	70			78	87	Y	8	8	8	8	-	8	Noticable	Noticable	Noticable	Noticable
NCA03	745589	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	3	COM	70	70	70	70			80	89	Y	10	10	10	10	-	10	Noticable	Noticable	Noticable	Noticable
NCA03	745588	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	2	COM	70	70	70	70			83	92	Y	13	13	13	13	-	13	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745587	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	1	COM	70	70	70	70			86	95	Y	16	16	16	16	-	16	Clearly Audible	Clearly Audible	Clearly Audible	Clearly Audible
NCA03	745130	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	10	RES	68	63	58	48			61	70		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	745129	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	9	RES	68	63	58	48			61	70		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	745128	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	8	RES	68	63	58	48			61	70		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	745127	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	7	RES	68	63	58	48			61	70		0	0	3	13	-	3	None	None	Noticable	Clearly Audible
NCA03	745126	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	6	RES	68	63	58	48			60	69		0	0	2	12	-	2	None	None	Noticable	Clearly Audible
NCA03	745125	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	5	RES	68	63	58	48			59	69		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	745124	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	4	RES	68	63	58	48			59	68		0	0	1	11	-	1	None	None	Noticable	Clearly Audible
NCA03	745123	"SE 1 LEVEL 2 20 CHARLES ST, PARRAMATTA"	3	RES	68	63	58	48			58	68		0	0	0	10	-	0	None	None	Noticable	Clearly Audible
NCA03	744949	"30 CHARLES ST, PARRAMATTA"	11	RES	68	63	58	48			70	80		2	7	12	22	-	12	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744948	"30 CHARLES ST, PARRAMATTA"	10	RES	68	63	58	48			71	80		3	8	13	23	-	13	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744947	"30 CHARLES ST, PARRAMATTA"	9	RES	68	63	58	48			72	81		4	9	14	24	-	14	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744946	"30 CHARLES ST, PARRAMATTA"	8	RES	68	63	58	48			72	82		4	9	14	24	-	14	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744945	"30 CHARLES ST, PARRAMATTA"	7	RES	68	63	58	48			73	82		5	10	15	25	-	15	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744944	"30 CHARLES ST, PARRAMATTA"	6	RES	68	63	58	48			74	83		6	11	16	26	-	16	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744943	"30 CHARLES ST, PARRAMATTA"	5	RES	68	63	58	48			74	84		6	11	16	26	-	16	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744942	"30 CHARLES ST, PARRAMATTA"	4	RES	68	63	58	48			75	85	Y	7	12	17	27	-	17	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744941	"30 CHARLES ST, PARRAMATTA"	3	RES	68	63	58	48			76	85	Y	8	13	18	28	-	18	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744940	"30 CHARLES ST, PARRAMATTA"	2	RES	68	63	58	48			76	86	Y	8	13	18	28	-	18	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744939	"30 CHARLES ST, PARRAMATTA"	1	RES	68	63	58	48			77	86	Y	9	14	19	29	-	19	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744938	"30 CHARLES ST, PARRAMATTA"	14	RES	68	63	58	48			69	78		1	6	11	21	-	11	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744937	"30 CHARLES ST, PARRAMATTA"	13	RES	68	63	58	48			69	79		1	6	11	21	-	11	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744936	"30 CHARLES ST, PARRAMATTA"	12	RES	68	63	58	48			70	79		2	7	12	22	-	12	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744903	"22 CHARLES ST, PARRAMATTA"	2	RES	68	63	58	48			74	83		6	11	16	26	-	16	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744902	"22 CHARLES ST, PARRAMATTA"	1	RES	68	63	58	48			74	83		6	11	16	26	-	16	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744901	"22 CHARLES ST, PARRAMATTA"	4	RES	68	63	58	48			73	82		5	10	15	25	-	15	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744900	"22 CHARLES ST, PARRAMATTA"	3	RES	68	63	58	48			73	83		5	10	15	25	-	15	Noticable	Clearly Audible	Clearly Audible	Moderately Intrusive
NCA03	744899	"22 CHARLES ST, PARRAMATTA"	10	RES	68	63	58	48			70	79		2	7	12	22	-	12	Noticable	Noticable	Clearly Audible	Moderately Intrusive

NCA03	744898	"22 CHARLES ST, PARRAMATTA"	9	RES	68	63	58	48			70	80		2	7	12	22	-	12	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744897	"22 CHARLES ST, PARRAMATTA"	8	RES	68	63	58	48			71	80		3	8	13	23	-	13	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744896	"22 CHARLES ST, PARRAMATTA"	7	RES	68	63	58	48			71	81		3	8	13	23	-	13	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744895	"22 CHARLES ST, PARRAMATTA"	6	RES	68	63	58	48			72	81		4	9	14	24	-	14	Noticable	Noticable	Clearly Audible	Moderately Intrusive
NCA03	744894	"22 CHARLES ST, PARRAMATTA"	5	RES	68	63	58	48			72	82		4	9	14	24	-	14	Noticable	Noticable	Clearly Audible	Moderately Intrusive

C.2 Vibration

NCA	Receiver	Address	Land use	Vibration Impact
NCA03	746686	"91 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746685	"91 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746684	"91 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746683	"91 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746163	"150 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746162	"150 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746161	"150 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746160	"150 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746159	"150 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746113	"140 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746007	"95-101 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746006	"95-101 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746005	"95-101 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746004	"95-101 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	746003	"95-101 GEORGE ST, PARRAMATTA"	COM	Cosmetic
NCA03	746002	"95-101 GEORGE ST, PARRAMATTA"	COM	Cosmetic
NCA03	745591	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	745590	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	745589	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	745588	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	COM	Human Comfort
NCA03	745587	"LEVEL 2 93 GEORGE ST, PARRAMATTA"	COM	Cosmetic