Penrith City Council

Kingswood Multi-Storey Commuter Car Park

Review of Environmental Factors

July 2022

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Kingswood Multi-Storey Commuter Car Park
Review of Environmental Factors
Penrith City Council

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	Name	Date	Signature
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Abbreviations

AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
ASS	Acid Sulfate Soils
ABS	Australian Bureau of Statistics
BC Act	*Biodiversity Conservation Act 2016*
BGL	Below ground level
CEMP	Construction Environmental Management Plan
CLMP	Community Liaison Management Plan
Council	Penrith City Council
CTMP	Construction Traffic Management Plan
dBA	A-weighted decibels
DPI	NSW Department of Primary Industries
DPE	NSW Department of Planning and Environment
EEC	Endangered Ecological Community
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	Environment Protection Authority
FM Act	*Fisheries Management Act 1994*
Heritage Act	*Heritage Act 1977*
HNA	Highly noise affected
NVA	Noise and Vibration Assessment
ICNG	Interim Construction Noise Guideline (NSW Department of Environment & Climate Change, 2009)
SEPP	State Environmental Planning Policy
LEP	Local Environmental Plan
LGA	Local Government Area
MNES	Matters of National Environmental Significance
NCA	Noise catchment area
NLT	*National Land Transport Act 2014*
NML	Noise management levels

NPfI	Noise Policy for Industry (EPA, 2017)
OOH	Out of Hours
POEO Act	*Protection of the Environment Operations Act 1997*
PSI	Preliminary Site Investigation
RBL	Rating background level
REF	Review of Environmental Factors
RNP	NSW Road Noise Policy
TPZ	Tree Protection Zone
Transport for NSW	Transport for New South Wales
WM Act	*Water Management Act 2000*
WMP	Waste Management Plan
WSP	WSP Australia Pty Ltd

Executive summary

Penrith City Council (Council) recognises the critical role commuter car parking plays in improving the quality of access to public transport for customers, particularly in the middle and outer metropolitan areas. Improving public transport for commuters is the focus of NSW Government transport initiatives. Commuter car parks are the gateways to the transport system and play a critical role in shaping customer experience of public transport, making it safe, easy, and reliable.

The proposal involves construction of a 14 metre high multi-storey commuter car park adjacent to the Kingswood Station. The multi-storey commuter car park would provide a minimum of 410 commuter car parking spaces, resulting in around 300 additional commuter car parking spaces and integration into the existing road and pedestrian network.

The proposal

Location

The proposal is located at 6 Cox Avenue, Kingswood on the corner of Cox Avenue and Richmond Road in the Penrith City Council Local Government Area (the proposal site). The new multi-storey commuter car park would occupy the existing at-grade Council car park on Lot 1 DP 198211, which has 114 commuter car parking spaces, and the existing Transport for NSW car park on Lot 5 DP 1187060.

The proposal site is situated directly north of Kingswood Station approximately 49 kilometres west of the Sydney Central Business District.

Need for the proposal

The proposal aims to deliver a minimum of 410 commuter car park spaces, resulting in around 300 additional commuter car parking spaces, to meet the social and environmental needs of the community (subject to ongoing design refinement and consistency assessment). Use of the commuter car park would be provided free of charge.

The proposal would encourage more people to travel to work by train, easing the burden on local roads, provide a pedestrian friendly shared access area (restricted access to Transport for NSW service vehicles) and reduce overflow to neighbouring off-street parking from future population growth, and therefore improve both local access to jobs as well as quality of life for residents.

Likewise, the proposal would improve safety and customer access to the public transport network, encourage a shift away from private vehicles and reduce congestion on the surrounding road network. The proposal would also provide bike storage, motorcycle parking and electronic vehicle charging stations to encourage alternate modes of transport to Kingswood Station to further reduce greenhouse gas emissions of commuters.

Key features

The key features of the proposal are:

- removal of the existing at-grade Council commuter car park
- construction of a multi-storey commuter car park comprising five levels
- a minimum of 410 new commuter car parking spaces, resulting in around 300 additional commuter car parking spaces, subject to ongoing refinement of the design
- around four accessible parking spaces, two spaces on the lower ground floor and two spaces on the ground floor
- around seven motorcycle parking spaces on the lower ground floor
- bike store for around fourteen bicycles on the lower ground floor
- around five electric vehicle charging stations, two spaces on the lower ground floor and three spaces on the ground floor
- 99-kilowatt solar panel array on the rooftop
- two vehicular access points, lower ground floor access via Richmond Road and ground floor access via Cox Avenue, with access/egress to the Transport for New South Wales carpark from the lower ground floor
- automated keyed retractable bollard access to shared access area for pedestrians and Transport for NSW vehicles
- new vehicle access to the Transport for NSW at-grade car park off Richmond Road.
- ancillary works including services diversion and/or relocation, drainage works, a ventilation system, vertical planting, landscaping, installation of lighting, installation of handrails and balustrades and new infrastructure (including wayfinding signage and CCTV cameras).

Construction

Subject to approval, construction is anticipated to commence in the start of quarter two of 2023 and take around 12 months to complete.

The works would be undertaken during standard NSW Environment Protection Authority (EPA) construction hours. Out of hours works may be required in some cases to minimise disruptions to commuters, pedestrians, motorists, and nearby sensitive receivers. Approval from Council would be required for any out of hours work and the affected community would be notified.

Construction of the proposal would require:

- site establishment and enabling works
- demolition and site clearing works
- earthworks including excavation and grading
- building and structural works
- landscaping and ancillary infrastructure
- testing and commissioning
- decommissioning of temporary facilities and site demobilisation.

The construction methodology would be further developed during the detailed design of the proposal by the nominated contractor in consultation with Penrith City Council. Any changes to the program or design would be reviewed in a consistency assessment to determine if an addendum to the Review of Environmental Factors (REF) is required.

Community and stakeholder engagement

Council consulted with Transport for NSW and Sydney Trains during development of the proposal. The REF would be placed on public display on the Penrith City Council website for two weeks starting from the end of July 2022. The public would be invited to read and provide submissions on the proposal during this exhibition period.

Environmental assessment

Potential environmental impacts from the proposal have been assessed and outlined in this REF. The following key impacts have been identified during construction and operation of the proposal:

- temporary noise, traffic, and visual impacts during construction
- removal of around 27 trees
- provision of around 9 new street trees and around 360 m^2 of landscaped areas, subject to ongoing refinement of the design
- long-term changes to the visual environment
- additional traffic movements associated with operation of the proposal.

Mitigation measures to minimise impacts have been identified and would be implemented during construction and operation of the proposal.

Justification and conclusion

The existing at-grade car park does not meet the parking requirements for the community and commuters. A new multi-storey commuter car park in this location would provide around 300 additional commuter car park spaces, subject to ongoing refinement of the design and consistency assessment.

The proposal aims to deliver a minimum of 410 commuter car parking spaces to meet the social and environmental needs of the community, as the proposal would encourage more people to travel to work by train, easing the burden on local roads and reduce overflow to neighbouring off street parking from future population growth, and therefore improve both local access to jobs and quality of life for residents. The proposal would improve safety and customer access to the public transport network and encourage a shift away from private vehicles.

Use of the commuter car park would be provided free of charge. A portion of the lower ground floor of the car park would be a storage area which has the potential to be converted to a commercial space in the future (subject to separate development approval).

The proposal would substantially increase commuter car parking in Kingswood, supporting increased use of public transport, while at the same time seeking to improve public amenity by implementing initiatives outlined in the Cooling the City Strategy (Penrith City Council, 2015). While around 27 existing trees would be removed by the proposal, the integration of vertical plantings and landscaping, including street trees (Spotted Gums and Brushbox) and understorey planting (plants and shrubs consistent with the Cumberland Plain Woodland) are proposed. These inclusions would also improve visual amenity for car park users and neighbours.

This REF has been prepared in accordance with the provisions of Part 5, Division 5.1, Section 5.5 of the *Environmental Planning and Assessment Act 1979*, taking into account all matters affecting or likely to affect the environment as a result of the proposal.

Based on the assessment contained in this REF, it is considered that the proposal is not likely to have a significant impact upon the environment, or any threatened species, populations, or communities and would not require approval under the *Environment Protection and Biodiversity Conservation Act 1999*. It is understood that ongoing refinement of the design would take into account the principles of Ecologically Sustainable Development to aim for a proposal that is cost effective and minimises any adverse impacts on the environment. It is understood that further refinement of the design is occurring. A consistency assessment would be prepared to confirm that the final proposal is consistent with this REF and to determine if additional investigations and/or an addendum REF are required.

1 Introduction

1.1 Overview

Penrith City Council (Council) recognises the critical role commuter car parking plays in improving the quality of access to public transport for customers, particularly in the middle and outer metropolitan areas of Greater Sydney, to encourage more people to travel to work by train, in order to ease congestion on local roads and reduce overflow to neighbouring street parking. Improving public transport for commuters is the focus of NSW Government transport initiatives. Commuter car parks are the gateways to the transport system and play a critical role in shaping customer experience of public transport, making it safe, easy, and reliable.

The proposal involves construction of a 14 metre high multi-storey commuter car park (with an approximately 16 metre high lift shaft) adjacent to the Kingswood Station in Kingswood. The proposed multi-storey commuter car park would provide a minimum of 410 commuter car parking spaces, resulting in around 300 additional commuter car parking spaces (subject to ongoing refinement of the design), and integration into the existing road and pedestrian network.

1.2 Location of the proposal

The proposal is located at 6 Cox Avenue, Kingswood on the corner of Cox Avenue and Richmond Road in the Penrith City Council Local Government Area (LGA), the adjacent Kingswood Station site and partly within the road reserve (the proposal site).

The proposal site is situated directly north of the Kingswood Station approximately 49 kilometres west of the Sydney Central Business District (refer to Figure 1.1). Kingswood Station is located on the Main Western Line and is serviced by T1 Western Line train services.

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Kingswood Commuter Car Park

Figure 1.1
Location of the Proposal

Legend

- Cadastre
- Proposal Site
- Council at-grade Car Park
- Transport for NSW Car Park

0 20 40
Meters

Coordinate system: GDA 1994 MGA Zone 56
Scale ratio correct when printed at A3
1:1,200 Date: 13/07/2022

Data sources: - DNRME, TMR, Translink, Geoscience Australia

www.wsp.com

1.2.1 The proposal site

The area that the proposed works would be undertaken is referred to as 'the proposal site'. The proposal site is relatively flat comprised primarily of at-grade car parking (refer to Figure 1.1) across two lots, Penrith City Council owned land, Lot 1 DP 198211 that contains an existing at-grade car park and the existing Transport for NSW car park on Transport for NSW land, part of Lot 5 DP 1187060. The parking areas are comprised of primarily paved surfaces, kerbs and gutters and a small area of landscaping. The proposal site also includes partial areas of the Cox Avenue, Richmond Road and Park Avenue road reserves.

The existing at-grade Council car park provides around 114 car parking spaces with vehicular access to Cox Avenue to the north and Richmond Avenue to the east (refer to Figure 1.2 and Figure 1.3). The car park is currently open from 8.30 am to 6.00 pm Monday to Friday and 8.30 am to 4.30 pm on Saturday. The Transport for NSW at-grade car park north of Kingswood Station provides around 70 car parking spaces, with no time restrictions. There is also an additional car park on the south side of the train station with no time restrictions, providing around 66 car parking spaces.

Figure 1.2 Photo of the existing commuter car park from the western border of the proposal site looking towards Richmond Road

Figure 1.3 Photo of existing commuter car park from the western boundary of proposal site looking towards Park Avenue

1.2.2 Surrounding land uses

The proposal site is bounded to the south by Kingswood Station, to the north by Penrith General Cemetery, to the east by medium density residential properties and to the west by commercial and industrial premises.

St Joseph's Primary School is located approximately 90 metres north-east from the proposal site along Richmond Road. Other nearby facilities include the Nepean Hospital and medical precinct to the south-west of the site on the south side of Kingswood Station. The Western Sydney University Campus is located to the south-east of the subject site and on the southern side of the Kingswood Station.

1.3 Purpose of this review of environmental factors

The purpose of this REF is to document likely impacts on the environment and to address environmental management requirements in relation to the proposal. Council is the proponent and the determining authority under Division 5.1, Section 5.5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

A description of the proposal and associated environmental impacts have been prepared in the context of Clause 171 of the NSW Environmental Planning and Assessment Regulation 2021 (EP&A Regulation) (environmental factors to be taken into account concerning the impact of an activity on the environment), the NSW *Biodiversity Conservation Act 2016* (BC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Clause 171 states that the determining authority must take into account environmental factors guidelines. Requirements of the recently released *Guidelines for Division 5.1 assessments* (Department of Planning and Environment [DPE], 2022) have generally been met by this REF; however, as the REF was finalised while the new REF guidelines were being released, some inconsistencies may exist.

The REF helps to fulfil the requirements of Division 5.1, Section 5.5 of the EP&A Act, that the proponent and determining authority (Council) examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity. It is understood that the proposal is still undergoing design refinement.

To achieve this, the report includes the following sections:

- Chapter 1 – Introduction: introduces the proposal, its location and the REF.
- Chapter 2 – Need for the proposal: outlines the strategic need for the proposal and the project alternatives considered.
- Chapter 3 – Proposal description: describes the design details of the Kingswood multi-storey commuter car park.
- Chapter 4 – Statutory context: outlines the planning approval pathway for the proposal and the relevant national, State and local statutes and planning instruments and guidelines that affect the proposal.
- Chapter 5 – Community and stakeholder engagement: provides a summary of Council's community and stakeholder consultation process to date and proposed future consultation.
- Chapter 6 – Environmental impact assessment: provides a detailed assessment of potential environmental impacts from the proposal, including Aboriginal and historical heritage, noise, traffic and access, biodiversity, soil, water, land contamination, air quality, visual amenity, waste management and socioeconomic impacts.
- Chapter 7 – Environmental management: details proposed environmental mitigation and management measures, as well as permits and licences required for the proposal.
- Chapter 8 – Justification and conclusion: provides justification for the proposal and summarises outcomes of the REF.

The REF considers the following:

- whether the proposal is likely to have a significant impact on the environment and therefore whether an environmental impact statement (EIS) is required to be prepared and approval sought from the Minister for Planning and Homes under Division 5.1, Section 5.7 of the EP&A Act
- whether the proposal is likely to have a significant impact on any threatened species or ecological communities as defined by the BC Act; and therefore, the requirement for a Species Impact Statement (SIS)
- potential for the proposal to significantly impact on Matters of National Environmental Significance (MNES) and the need to make a referral to the Commonwealth Government Department of Climate Change, Energy, the Environment and Water under the EPBC Act.

2 Need for the proposal

2.1 Strategic need

Improving transport customer experience is the focus of the NSW Government's transport initiatives. Transport interchanges and train stations are important gateways to the transport system and play a critical role in shaping the customers experience of public transport.

More people living in Penrith drive to work compared to the rest of Greater Sydney (Australian Bureau of Statistics [ABS], 2016). Analysis of the method of travel to work of the residents in Penrith City in 2016, shows that 11 per cent used public transport, while 75 per cent used a private vehicle, compared with 16 per cent and 65 per cent respectively in Greater Sydney (ABS, 2016). This reliance on car travel places pressure on road infrastructure in the Penrith City Council LGA, increasing vehicle emissions and commuting times, and ultimately reducing time spent with family and enjoying the Penrith lifestyle.

The proposal aims to deliver a minimum of 410 commuter car park spaces, resulting in around 300 additional commuter car parking spaces (subject to ongoing refinement of the design), to meet the social and environmental needs of the community. The proposal would encourage more people to travel to work by train, easing the burden on local roads, provide a pedestrian friendly shared access area (restricted access to Transport for NSW service vehicles) and reduce overflow to neighbouring off-street parking from future population growth, and therefore improve both local access to jobs as well as quality of life for residents. Likewise, the proposal would improve safety and customer access to the public transport network, encourage a shift away from private vehicles and reduce congestion on the surrounding road network. Bike storage, motorcycle parking and electric vehicle charging stations would be provided to encourage alternate modes of transport to Kingswood Station to further reduce greenhouse gas emissions of commuters.

The proposal would also allow for the Transport for NSW car park north of Kingswood Station to be established as a shared access zones for safe pedestrian movement, with vehicle access restricted in this area to Transport for NSW service vehicles via an automated keyed bollard retraction system.

Use of the commuter car park would be provided free of charge.

2.2 Strategic context

The proposal aligns with Commonwealth, State and local strategic plans and policies as described in this section.

2.2.1 Australian Government Urban Congestion Fund

The proposal is funded through the Australian Government Urban Congestion Fund, outlined under Part 3 of the *National Land Transport Act 2014* (NLT Act). The fund aims to encourage greater use of public transport to support reduced travel times and vehicle operation costs, increase access to facilities and services and improve urban liveability. Projects funded under the NLT Act are governed by the National Partnership Agreement between the Commonwealth and State Governments.

The Australian Government recognises that infrastructure investments to manage growth and reduce congestion are critical to ensuring Australians continue to experience a high quality of life. This includes a recognition that commuter car parking helps make rail networks more accessible and takes cars off the road.

2.2.2 NSW Government

2.2.2.1 A Metropolis of Three Cities – the Greater Sydney Region Plan

The *Greater Sydney Region Plan* (Greater Sydney Commission, 2018a) seeks to meet the needs of a growing and changing population by transforming Greater Sydney into a metropolis of three cities – the Western Parkland City, the Central River City and the Eastern Harbour City. The *Western City District Plan* (Greater Sydney Commission, 2018b) as part of the Greater Sydney Region Plan sets out the planning priorities and actions for improving the quality of life for Western Sydney residents. This proposal is consistent with the objectives of the Planning Priorities featured in the plan as follows:

- Planning Priority W1 – Planning for a city supported by infrastructure i.e. Infrastructure supporting new developments.
- Planning Priority W2 – Working through collaboration i.e. Working together to grow a Greater Sydney (Greater Sydney Commission, 2018b).

The construction of a multi-storey commuter car park adjacent to Kingswood Station would help support the vision of a Metropolis of Three Cities, improving connections within each of the cities and aligning forecast population growth with infrastructure. It would result in improved access to public transport and the associated access to a greater choice of jobs to a larger section of the Penrith population and reduce urban congestion. The proposal aligns with the *Western City District Plan* (Greater Sydney Commission, 2018) that aims to improve liveability and achieve a productive and sustainable future for the District.

2.2.2.2 Future Transport Strategy 2056

The *Future Transport Strategy 2056* (Transport for NSW, 2016) is a suite of strategies and plans that set out the 40 year vision, direction and principles for customer mobility in NSW, guiding transport investment over the longer term (Transport for NSW, 2016). One of the outcomes of the *Future Transport Strategy 2056* include transport providing convenient access, supporting attractive places and providing 30 minute access for customers to their nearest centre by public transport. The proposal is consistent with the overall aims of the *Future Transport Strategy 2056* to improve transport infrastructure across NSW. The proposal would deliver on the focus on transport customers and would support improved commuter experience by improving accessibility to public transport. The proposal also supports the sustainability objective of the *Future Transport Strategy 2056* by encouraging the use of public transport and including a number of key sustainability initiatives to be implemented into the design of the proposal (Transport for NSW, 2016).

A part of the *Future Transport Strategy 2056* is the NSW Electric and Hybrid Vehicle Plan, which sets out goals for the next five years focussed on three key priority areas: vehicle availability; charging stations; and customer information (Transport for NSW, 2016). The proposal includes provision for charging electric vehicles.

2.2.2.3 NSW State Infrastructure Strategy 2018-2038

The *NSW State Infrastructure Strategy 2018-2038* (Infrastructure NSW, 2018) builds on the NSW Government's major long-term infrastructure plans . Public transport is viewed as critical to urban productivity, expanding employment opportunities by connecting people to jobs, reducing road congestion, and supporting the delivery of urban renewal (Infrastructure NSW, 2018). The proposal supports investment in public transport and aligns with the need to provide the community with accessible public transport as well as reduce congestion.

2.2.3 Local

2.2.3.1 Penrith Community Plan 2017

The *Penrith Community Plan* (Penrith City Council, 2017) outlines community aspirations along with proposed works over the next 20 years. Community consultation has led Council to have a strong focus on improving roads, public transport parking and pathways in order to reduce congestion across the LGA. The delivery of a multi-storey commuter car park would allow commuters additional parking amenity and access to public transport.

2.2.3.2 Cooling the City Strategy 2015

Located at the basin of greater Sydney and within the terrain of the neighbouring Blue Mountains, Penrith's topography leads to consistently higher temperatures and lower rainfall than in the more coastal parts of Sydney. One of the main contributors to rising temperatures is the urban heat island effect; a phenomenon whereby an excess of hard reflective surfaces in heavily urbanised areas results in unusually higher temperatures. Penrith City Council has identified the need to increase green cover, shade and landscaping to reduce surface temperatures as outlined in the Cooling the City Strategy (Penrith City Council, 2015). The proposal has integrated vertical plantings and landscaping, including the planting of new street trees (Spotted Gums and Brushbox) with a native understorey on Richmond Road, Cox Avenue and within the existing Transport for NSW car park area, in an attempt to minimise potential urban heat island impacts of the proposal.

2.2.3.3 Penrith Community Safety Plan 2018-22

The *Penrith Community Safety Plan 2018-22* (Penrith City Council, 2018) outlines Council's commitment to promoting Penrith as a safe and vibrant city, emphasising the importance of a 'whole of community' approach to fostering places where people feel safe and well-connected. The Plan builds on the success of Council's three previous plans which resulted in several adopted policies that support community safety and crime prevention strategies. These proposal design has considered the following:

- Crime Prevention through Environmental Design (CPTED) Development Control Plan: outlines design controls to help minimise the crime risk of new development, such as appropriate lighting, security features, landscaping and building design.
- Public Domain Lighting Policy: provides guidelines for appropriate lighting in public spaces in accordance with best practice and Australian Standards.
- Public Spaces Closed Circuit Television (CCTV) Program Code of Practice: outlines management practices for Council's public spaces CCTV cameras in accordance with relevant legislation.

2.2.3.4 Penrith Local Strategic Planning Statement 2020

The *Penrith Local Strategic Planning Statement* (LSPS) (Penrith City Council, 2020) presents a local vision for land use within the Penrith LGA, that recognises the character of its suburbs. Kingswood, including the station and the proposal site, are identified as a 'key centre' within the Greater Penrith to Eastern Creek Growth Area. As such Kingswood is one of three key centres identified '*to accommodate mixed-use and high density residential developments'*. In addition, Planning Priority 21 aims to mitigate urban heat in Penrith and includes specific targeted building and design responses. In response, the proposal design has considered the following:

- increasing the Kingswood car park capacity by around 300 additional commuter car parking spaces, plus a bike store, motorcycle parking and electric vehicle charging stations, that would encourage the use of public transport and reduce emissions
- integration of vertical planting and landscaping (including street trees) to enhance urban greenery and provide a green facade that would reduce the heating impact of the proposed multi-story commuter car park
- incorporation of sustainability elements such as solar panels and rainwater collection for landscape irrigation and toilet flush.

2.3 Objectives of the proposed car park

The proposal aims to deliver a well-designed multi-storey commuter car park that meets the needs of the community. The proposal would substantially increase commuter car parking in Kingswood, support increased use of public transport and ease urban congestion. The key objectives for proposal are outlined in Table 2.1.

Table 2.1 Objectives of the proposal

Objective	Benefits
Reduce congestion	The multi-storey commuter car park would centralise parking on Council-owned land and significantly reduce commuter overflow parking to neighbouring streets from future population growth.
Reduce costs	Commuters would have the opportunity to reduce their vehicle operating costs including fuel, maintenance and parking fees, by avoiding driving to work.
Enhance Connectivity	The multi-storey commuter car park facility in close proximity to Kingswood Station would enhance connectivity of residents and commuters to business districts accessible via the rail network.
Improve amenity	The multi-storey commuter car park would provide ease of access and less distance to walk from neighbouring kerbside parking. This would increase accessibility to the rail network, especially for individuals with mobility issues.
Cool the City	Integration of vertical plantings and landscaping would help mitigate urban heat island effects and reduce temperatures within the car park for a better commuter experience. Landscaping would include street trees, Spotted Gums and Brushbox, that would provide shade. The street trees would be complemented by understorey planting, with native plants and shrubs. These inclusions would also improve visual amenity for car park users and neighbours.
Increase biodiversity	The vertical plantings and landscaping, including street trees, would seek to enhance local native flora and fauna.
Improve safety	Update security surveillance and lighting to provide a safer access to public transport for commuters.
Reduce emissions	Environmental impacts from private vehicle use relate mainly to air pollution and greenhouse gas emissions. Encouraging commuters to use public transport would result in fewer greenhouse gas emissions. Further inclusion of electric vehicle charging stations would encourage new and existing electric vehicle owners to utilise public transport.
Improve sustainability	Inclusion of solar panels, ‘green’ concrete, energy efficient lighting and rainwater tanks which would reduce carbon emissions and operating costs, subject to refinement of the design.

2.4 Options considered

The proposal considered three options considered by Council, including a ‘do-nothing’ option. The strategic need and objectives were considered in the options assessments. Council recognised the opportunity to not only meet the demands of the community for more parking near the train station, but to also demonstrate their leadership by delivering a project that integrates vertical planting and landscaping to enhance the visual amenity of the commuter car park.

Only one location was considered for this proposal at the corner of Cox Avenue and Richmond Road on Lot 1 DP198211 and Lot 5 DP 1187060. The Council owned site at 6 Cox Avenue, Kingswood was selected due to proximity to the Kingswood Station and the existing land use as an at-grade commuter car park.

2.4.1 Option 1: ‘Do nothing’

Under a ‘do-nothing’ option, existing access to the commuter car park would remain the same and there would be no changes to the limited parking capacity at the station. This option would not meet the strategic needs or objectives of the proposal.

2.4.2 Option 2: Construct a new multi-storey commuter car park with three levels

This option would redevelop the existing car park as a new multi-storey commuter car park consisting of three levels. The three level car parking structure would provide around 250 commuter car parking spaces resulting in around an additional 135 car parking spaces.

This option is forecast to only meet current requirements and would not meet the needs of Penrith’s growing population. This option also would not adequately provide for landscaping and aesthetic upgrades to meet requirements for Council’s planning approval, including works to the adjacent land owned by Transport for NSW.

2.4.3 Option 3: Construct a new multi-storey commuter car park with five levels

This option would redevelop the existing car park as a new multi-storey commuter car park consisting of five levels. The new car parking structure would provide a minimum of 410 commuter car parking spaces, resulting in around 300 additional car parking spaces, subject to ongoing refinement of the design. This option includes an enhanced façade and greening, including landscaping of Transport for NSW land.

This option would meet the strategic needs and objectives of the proposal and encourage use of public transport that would result in reduced private car use.

2.5 Justification for the preferred option

Option 3 was considered as the preferred option as it aligns with the stated objectives noted in Section 2.3. A summary comparison of the options assessed by Council with objectives is summarised in Table 2.2. This REF describes and assesses Option 3 as the proposal.

Table 2.2 Options assessment summary

Objectives	Option 1	Option 2	Option 3	Rationale
Reduce congestion	✗	✓	✓	Option 1 would not address congestion. Option 2 would reduce congestion in the short-term through provision of additional parking spaces but it would not provide sufficient capacity for future growth. Option 3 would provide for population growth through centralised parking on Council-owned land to reduce future commuter overflow parking to arterial roads and neighbouring streets.
Reduce costs	✗	✓	✓	Option 1 would not change costs for commuters. Options 2 and 3 would provide opportunity to reduce vehicle operating costs for commuter's including fuel, maintenance, and parking fees.
Enhance Connectivity	✗	✓	✓	Option 1 would maintain the existing car parking as is. Options 2 and 3 would improve commuter access to Kingswood Station. Option 3 would provide the greatest connectivity due to the increased number of parking spaces.
Improve amenity	✗	✓	✓	Option 1 would not provide amenities. Options 2 and 3 would provide a greater improvement in amenity outcomes including accessible spaces, electric vehicle charging stations, bike storage, lifts, and lighting.
Cool the City	✗	✓	✓	Option 1 would maintain the existing car parking as is. Option 2 and Option 3 would integrate vertical plantings and landscaping. Option 3 provides a greater number of commuter car parking spaces to allow the establishment of a shared access landscaped corridor within the current Transport for NSW northern car park (which would only be accessible by Transport for NSW service vehicles to enhance pedestrian safety).

Objectives	Option 1	Option 2	Option 3	Rationale
Increase biodiversity	✗	✓	✓	Option 1 would maintain the existing car parking as is. Option 2 and Option 3 would integrate vertical plantings and landscaping to enhance biodiversity as far as reasonably practicable. Option 3 would provide amenity outcomes with a larger area of vertical plantings due to increased height of the car park as well as the opportunity for additional landscaping at ground level, allowing for the establishment of a landscaped shared access corridor within the current northern Transport for NSW car park.
Improve safety	✗	✓	✓	Update security surveillance and lighting to provide a safer access to transport.
Reduce emissions	✗	✓	✓	Option 1 would maintain the existing car parking as is. Option 2 and Option 3 would both provide more commuter car parking spaces to increase public transport patronages. Option 3 would provide an increased number of commuter car parking spaces and include solar panels to support operations of the proposal including lighting and lifts as well as providing electric vehicle charging stations.
Improve sustainability	✗	✓	✓	Option 1 would maintain the existing car parking as is. Option 3 would provide move enhanced sustainability initiatives including solar panels, rainwater tanks, and landscaping. Option 3 would provide a greater opportunity for sustainability initiatives over Option 2, as the additional floor area allows for the addition of solar panels within the rooftop parking level, while retaining a larger number of commuter car parking spaces. Likewise, Option 3, would allow for additional landscaping within the existing Transport for NSW car park north of Kingswood Station to establish a landscaped shared access area for pedestrians, which would only be accessible by Transport for NSW service vehicles.

3 Proposal description

3.1 Proposal overview

The proposal involves construction of a multi-storey commuter car park on the site of an existing at-grade Council car park on the corner of Cox Avenue and Richmond Road in Kingswood. The multi-storey commuter car park would provide a minimum of 410 commuter car parking spaces, resulting in around 300 additional commuter car parking spaces (subject to ongoing refinement of the design), and integration into the existing road and pedestrian network.

Key features of the proposal are:

- removal of the existing at-grade Council car park
- construction of a multi-storey commuter car park comprising five levels
- a minimum of 410 new commuter car parking spaces, resulting in around 300 additional commuter car parking spaces, subject to ongoing refinement of the design
- solar panels on the rooftop (99 kilowatt solar photovoltaic array)
- two vehicular access and egress points on Cox Avenue and Richmond Road
- construction of a new shared access road (restricted vehicle access) to the Transport of NSW at-grade car park off Richmond Road.

3.2 Key features

The key features of the proposal are outlined in the following sections. The description of the proposal is based on the concept design and would be subject to refinement of the design. The concept design is provided in Appendix A.

3.2.1 At-grade car park removal

The existing at-grade Council car park consisting of around 114 car parks would excavated and be removed.

3.2.2 Multi-storey car park

The multi-storey commuter car park comprising five levels (lower ground, ground, first floor, second floor, third floor) would include:

- a minimum of 410 new commuter car parking spaces, resulting in around 300 additional commuter car parking spaces, subject to ongoing refinement of the design
- approximately four accessible parking spaces, two spaces on the lower ground floor and two spaces on the ground floor
- approximately seven motorcycle parking spaces on the lower ground floor
- bike store for fourteen bicycles on the lower ground floor
- approximately five electric vehicle charging stations, two spaces on the lower ground floor and three spaces on the ground floor
- 99-kilowatt solar panel array on the rooftop.

The structure of the multi-storey commuter car park would be approximately 14 metres high with the lift shaft reaching height of approximately 16 metres. Internal circulation in the car park would be provided by two lifts and two stairs for pedestrians, and ramps for vehicles. Lifts would be centrally located and align with a clear pedestrian spine that traverses the car park in a north south direction. Ramps are single for one-way movement only. Wayfinding signage would be installed.

The facade to the reinforced concrete structure would use a series of folded mesh screens, with façade planting on the north and east elevations. An artist impression of the proposed façade is shown in Figure 3.1. The transparency of the screen creates shading and allows for planting to creep through, softening the façade with foliage. The vertical plantings on the façade would be created with internal planters, which are proposed to house native species.

The bicycle storage and waste storage facilities would be located on the lower ground floor which would be accessible from the Transport for NSW car park (see Figure 3.2). In the south-east corner of the lower ground floor there would be a storage area with the potential to be converted to a commercial space in the future. The potential commercial use would be subject to separate development approval and is excluded from the scope of this proposal. A solar photovoltaic array would be arranged on the rooftop to provide energy to the new car park.

The potential for a bridge link to be incorporated would be considered during the refinement of the design and would be assessed within the consistency report and/or addendum REF if included in the final design.

Figure 3.1 Photomontage of finished Kingswood commuter car park

3.2.3 Vehicle access

Two vehicular access and egress points to the multi-storey commuter car park would be located on:

- Richmond Road, with access to the lower ground level of the car park
- Cox Avenue, with access to ground level (see Figure 3.2).

The multi-storey commuter carpark would also provide access and egress to the Transport for NSW car park located on the northern side of Kingswood Station. A shared access zone would be established between Richmond Road and this car park. Vehicle access within the shared access zone would be controlled via automated retractable keyed bollards, and would be accessible by Transport for NSW service vehicles and emergency services.

To accommodate the new access road, the existing kiss and ride shelter would be removed and relocated north on Richmond Road adjacent to the new multi-storey commuter car park.

3.2.4 Ancillary works

Ancillary works are required to support development of the multi-storey commuter car park. These works include service diversion and/or relocation, drainage works, landscaping, installation of lighting and installation of a ventilation system.

Stormwater drainage and utility services adjustments are required in Park Avenue, Cox Avenue and Richmond Road. A sewage pump out system is proposed to service the proposed car park facilities. As ancillary works are still being designed they would be considered with other design refinements in the consistency assessment (refer Section 1.3) prior to works occurring.

Landscaping is proposed to the south of the multi-storey commuter car park and new street trees are proposed on Cox Avenue and Richmond Road (see Figure 3.2). The concept design has identified 21 trees for removal and retention, however around 27 trees may need to be removed to facilitate construction of the proposal. The proposal would seek to offset the trees proposed to be removed. Wayfinding signage would be installed. No advertising signage is proposed.

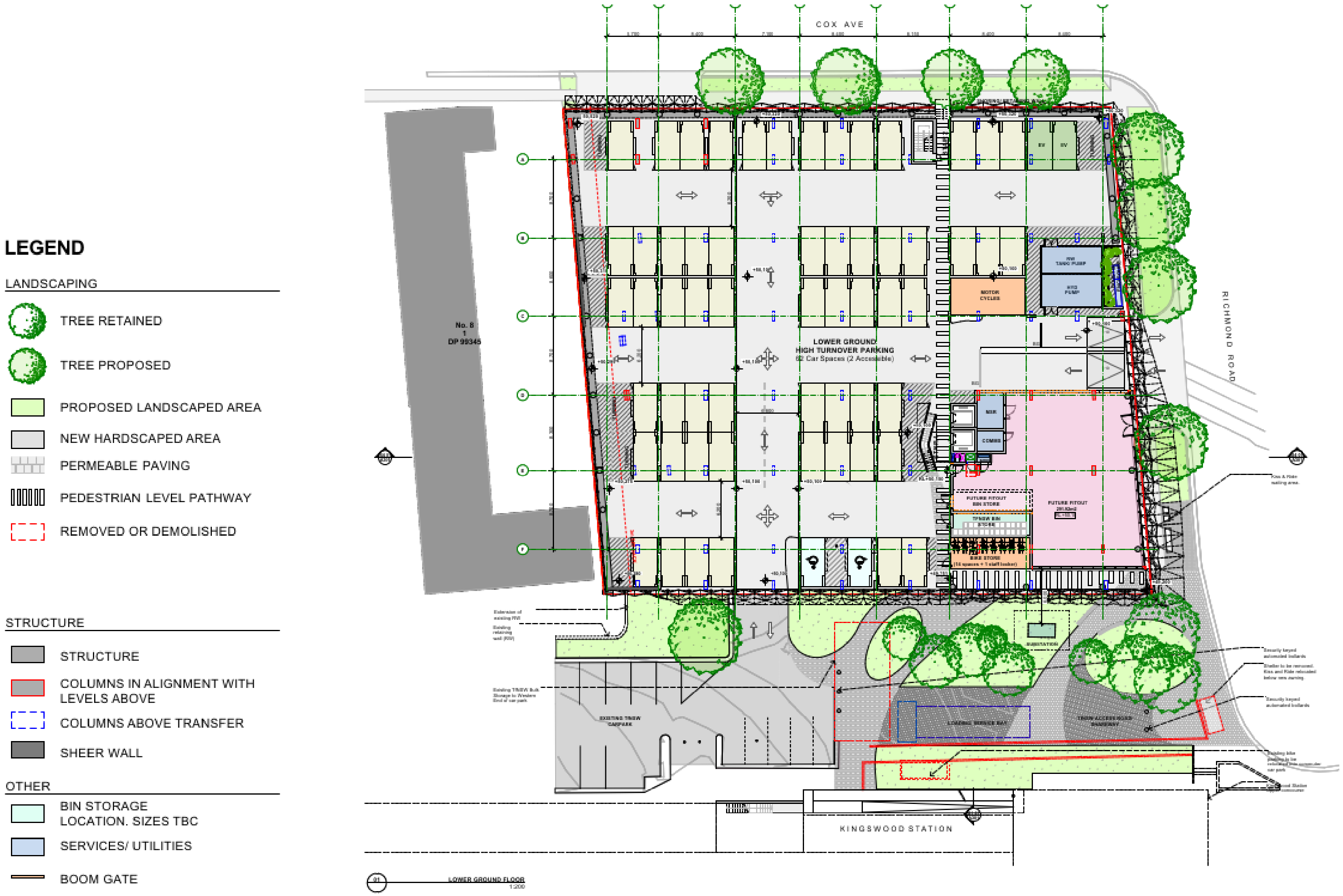


Figure 3.2 Concept design of the lower ground floor of the car park (subject to refinement of the design)

3.3 Sustainability in design

The proposal would be designed in compliance with Council's Sustainable Building Design Checklist 2021 – Final Draft 2 – where reasonably practicable, and the *NSW Sustainable Design Guidelines – Version 4.0* (Transport for NSW, 2019) which groups sustainability into seven themes:

- Energy and greenhouse gases
- Climate resilience
- Materials and waste
- Biodiversity and heritage
- Water
- Pollution control
- Community benefit.

In line with the sustainability strategies, it is proposed that the car park would adopt a Green Urbanisation approach, including vertical planting and solar panels to offset the cost of electricity. The proposed key sustainability initiatives to be implemented include:

- vertical plantings including automatic watering system
- rainwater tanks for landscape irrigation and toilet flush
- roof shading 99 kilowatt solar panels to the rooftop
- energy efficient LED lighting
- electric vehicle charging stations
- possible adoption of modular design and construction methods such as 'green concrete' that provides carbon savings.

Further positive impacts in relation to climate change and sustainability associated with the proposal include encouraging a reduction in private vehicle use and increased accessibility of public transport services.

3.4 Construction activities

3.4.1 Methodology

Construction activities for the proposal are identified in Table 3.1. The staging is indicative and is based on the current concept design and may change once the detailed design and construction methodology is finalised. Changes to the construction staging would be addressed in the consistency assessment (refer Section 1.3) prior to works occurring.

Table 3.1 Indicative construction staging for key activities

Stage	Description
Site establishment (Shared access road construction)	— Secure area — Install project signage — Establish pedestrian and traffic controls for access road works — Establish environmental controls for access road works, such as erosion and sediment controls — Identify and mark trees to be retained and removed with the arborist to assess root mapping of trees to be retained to confirm extent of tree protection area — Demolish existing foot path — Clear site of vegetation not being retained, including grubbing of all stumps of trees to be removed — Temporary relocation of existing kiss and ride shelter on Richmond Road to the north of the existing location — Shared road to access Transport for NSW land to be constructed first, prior to blocking off access through the proposal site. Pedestrian access on the shared road would be maintained throughout the construction phase of the proposal. Access would be maintained to Kingswood Station for commuters during construction.
Site establishment (multi-storey commuter car park)	— Secure site perimeter boundary with temporary fencing — Install project signage — Undertake survey to identify site boundary and mark out existing services — Establish pedestrian and traffic controls — Establish site office, amenities and plant/material storage areas — Establish environmental controls, such as erosion and sediment controls — Protection and diversion of utilities within the proposal site.
Demolition and site clearing works	— Clear site of any remaining vegetation not being retained, including grubbing of all stumps of trees to be removed — Demolish existing asphalt and existing structures (e.g. bollards, shelter) — Demolish obsolete kerbs in existing car park — Removal and salvage of kiss and ride shelter — Demolish existing drainage.
Earthworks	— Excavation and regrading of the site in preparation for the multi-storey car park and road network integration works — Trenching for underground utility works.

Stage	Description
Building and structural works	— Prepare the site for the construction of footings — Construct piled foundations, footings and pile caps over new piles — Form and pour ground flood slabs — Construct levels, including stairs, walls and columns one level at a time — Construct blockwork on each level — Install new lifts — Install electrical, hydraulic and mechanical services infrastructure including ventilation.
Architectural features	— Install protective screens around building perimeter — Install vehicle crash barriers, balustrades, new cladding — Paint car park concrete elements — Mark car park lines, direction arrows and installation of way finding signage — Instal ancillary features including fire protection, CCTV, electrical elements, and solar panels.
Precinct works	— Remove of the existing bike shelter — Construct pavement and hardscaped area works — Relocate and consolidate Transport for NSW waste storage within multi-storey commuter car park — Instal new wayfinding signage, as required — Undertake landscaping works — Instal off-line rain gardens and connections to stormwater.
Testing and commissioning	— Complete activities to test and commission power supply, lifts, security, and lighting.
Decommissioning of temporary facilities and site demobilisation	— Remove temporary site facilities — Remove footpath/pedestrian management and traffic controls — Remove environmental controls — Complete site clean-up and tidying works.

3.4.2 Plant and equipment

The plant equipment likely to be used during construction includes:

- Tower and mobile cranes
- Water truck
- Street sweeper
- Road saw
- Vibratory rollers
- Trench compactors
- Concrete pump
- Semi-trailers
- Spoil trucks
- Welding equipment
- Air compressors
- Concrete saws
- Generators
- Concrete vibrators
- Jack hammers
- Demolition saw
- Dozer
- Grader
- Excavators
- Elevated work platforms
- Paving machine
- Lighting towers
- Scaffolding
- Various hand tools
- Stump grinder.

3.4.3 Duration and working hours

Subject to approval, construction is expected to commence in the start of quarter two of 2023 and take around 12 months to complete. The construction methodology would be further developed during the detailed design of the proposal by the nominated contractor in consultation with Penrith City Council.

The works required for the proposal would be undertaken during standard NSW Environment Protection Authority (EPA) construction hours, which include the following:

- 7 am to 6 pm Monday to Friday
- 8 am to 1 pm Saturdays
- no work on Sundays or public holidays.

Out of hours works is not anticipated, but should it be required to minimise disruptions to commuters, pedestrians, motorists and nearby sensitive receivers, approval from Council would be sought and the affected community would be notified.

3.4.4 Construction workforce

The construction workforce for the proposal would include a peak workforce of approximately 70 workers over the 12 month construction phase. On average, there would be about 15 workers in off-peak periods.

Penrith City Council would implement its *Indigenous Participation Plan (2022)* for the proposal to promote the inclusion of Indigenous people in the construction workforce and provide training and upskilling opportunities.

3.4.5 Ancillary facilities

A site compound/laydown area would be established within the Transport for NSW car park during construction of the proposal for the storage of materials and equipment. The proposal site and nominated compound/laydown area is shown in Figure 3.3.

3.4.6 Access and vehicle movements

Access to the construction site would be primarily via Richmond Road and Cox Avenue. The shared road to access the Transport for NSW car park adjacent to the proposal site would be constructed first, prior to blocking off access through the proposal site. The shared access road would form a landscaped corridor for pedestrians accessing the station from the new multi-storey commuter car park, and would only be accessible by Transport for NSW service vehicles, via automated retractable keyed bollards. Pedestrian access to the Transport for NSW car park and Kingswood Station would be maintained during construction.

Construction works would generate two to ten truck movements per hour across the construction program and 30 to 50 truck movements daily during peak activities (around a six to eight week period). Traffic and transport impacts associated with the proposal are assessed in Section 6.1 of this REF.

Kingswood Commuter Car Park

Figure 3.3
Indicative Construction Layout

Legend

- Cadastre
- Proposal Site
- Council at-grade car park
- Transport for NSW car park
- Construction Compound
- Site and TfNSW Carpark Access

0 20 40
Meters

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

1:1,200 Date: 13/07/2022

Data sources: - DNRME, TMR, Translink, Geoscience Australia

3.4.7 Public utility adjustments

The proposal has been designed to avoid relocation of services where feasible; however, further investigation may be required. In the event that works would be required outside the proposal site, further assessment would be undertaken as necessary in the consistency assessment (refer Section 1.3) prior to works occurring.

3.4.7.1 Earthworks

Due to the relatively flat nature of the proposal site, earthworks during construction would be to the extent required to excavate the lower ground floor car park. Additionally, following removal of existing bitumen and subgrade, excavation works would be required to allow for footings and pits for lift shafts. General trenching, excavation and/or grading would also be required for installing services, drainage works, new paving, and tree removal. As the extent of work for ancillary activities is not yet known further assessment would be undertaken as necessary in the consistency assessment (refer Section 1.3) prior to works occurring.

There would be estimated bulk earthworks of about 3,670 cubic metres. Excavated material would be reused on site where practicable or disposed of in accordance with relevant waste legislation requirements.

3.5 Operation and maintenance

Future operation and maintenance of the car park and landscape areas constructed under this proposal would be carried out by Penrith City Council.

4 Statutory considerations

Chapter 4 provides a summary of the statutory considerations relating to the proposal including a consideration of NSW Government policies/strategies, NSW legislation (particularly the EP&A Act), environmental planning instruments, and Commonwealth legislation.

4.1 Commonwealth legislation

4.1.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act provides a national framework for environmental protection and management of nationally internationally important flora, fauna, ecological communities, and heritage places. Part 3 of the Act lists nine Matters of National Environmental Significance (MNES) that require approval from the Commonwealth Minister for the Environment and Water.

In addition, an action taken by any person on Commonwealth land that is likely to have a significant impact on the environment (Section 26(1)) or an action taken by any person outside of Commonwealth land that is likely to have a significant impact on MNES (Section 26(2)) may require approval from the Commonwealth Minister for the Environment and Water. Refer to Appendix B for consideration of MNES and Commonwealth land.

The assessment of the proposal concluded that it is not likely to have a significant impact on any MNES, is unlikely to impact Commonwealth land and referral under the EPBC Act is not required.

4.1.2 Other commonwealth legislation

Table 4.1 Other Commonwealth legislation

legislation	Consideration
Aboriginal and Torres Strait Islander Heritage Protection Act 1984	The proposal does not include any previously identified Aboriginal sites and/or places (refer to Section 6.6). Mitigation measures that would be implemented in the event of an unexpected find are provided in Section 7.2.
Disability Discrimination Act 1992 (DDA)	The proposal would be designed having regard to the requirements of this Act. Accessible parking spaces would be provided on the lower ground and ground floor and lift access would be provided to the additional car park levels.

4.2 NSW legislation

4.2.1 Environmental Planning and Assessment Act 1979 (EP&A Act)

The EP&A Act is the principal Act relating to development in New South Wales. The Act allows for development to occur as exempt, with consent and without consent.

The relevant planning approval process for development is set out in environmental planning instruments (EPIs); State Environmental Planning Policies (SEPPs) and local environmental plans (LEPs). Under the provisions of State Environmental Planning Policy (Transport and Infrastructure) 2021 (Transport and Infrastructure SEPP), the proposal is permitted without consent under Part 5 of the EP&A Act (refer Section 4.3).

Council is both the proponent and the determining authority under Part 5 Division 5.1 of the EP&A Act. Section 5.5 of the EP&A Act imposes a duty on determining authorities to consider '*to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity*.' Should Council find that the proposal would be likely to have a significant impact on the environment, Section 5.7 of the EP&A Act would require an environmental impact statement (EIS) be prepared for the proposal.

Clause 171 of the Environmental Planning and Assessment Regulation 2021 (EP&A Regulation) identifies factors that must be considered when determining if an activity assessed under Division 5.1 of the EP&A Act has or is likely to have a significant impact on the environment. This REF provides an environmental impact assessment of the proposal in accordance with Clause 171 and Appendix C addresses factors for consideration under Clause 171 of the EP&A Regulation.

4.2.2 Other NSW legislation

Other legislative and approval requirements relevant to the proposal are outlined in Table 4.2.

Table 4.2 Other legislation relevant to the proposed project

Legislation	Purpose	Relevance to the proposal and approval requirements
Biodiversity Conservation Act 2016	The *Biodiversity Conservation Act 2016* (BC Act) aims to maintain a healthy, productive and resilient environment for the well-being of the community.	A search on the EPBC Protected Matters Search Report undertaken on 8 July 2022 found 7 listed Threatened Ecological Communities (TECs), 43 listed Threatened species and 13 listed Migratory species within 500 metres of the proposal site (refer Appendix K). The site, however, does not contain suitable habitat for any listed threatened species or community and the proposal is unlikely to have a significant impact on any threatened species or community (refer Section 6.5).
Biosecurity Act 2015	The primary object of the *Biosecurity Act 2015* is to provide a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter, including pests, diseases and contaminants. Part 22 Division 2 requires Council to manage the biosecurity risk posed by weeds on land they control.	Section 22 of the Act states any person who deals with a biosecurity matter has a duty to ensure that in so far as is reasonably practicable, the potential biosecurity risk is prevented, eliminated or minimised. Appropriate management methods would be implemented during construction if declared noxious weeds in the Penrith local government area were identified (refer to Section 6.5).

Legislation	Purpose	Relevance to the proposal and approval requirements
Contaminated Land Management Act 1997	The *Contaminated Land Management Act 1997* establishes a process for investigating and remediating land that the EPA considers to be contaminated significantly enough to require regulation under Division 2 of Part 3.	An online search on the EPA Contaminated Land Register was conducted on 30 March 2022 and no contaminated land was identified on or within close proximity of the proposal site. A Preliminary Site Investigation (PSI) was prepared for Lot 1 DP198211 and identified potential contamination on the site (summary provided in Appendix J). The PSI considered that Lot 1 DP198211 can be made suitable for the proposed development subject to further investigation for volatile organic compounds from the clearing chemicals warehouse immediately west of the site and an unexpected finds protocol be developed.
Crown Land Management Act 2016	The Act aims to effectively manage Crown land including environmental, social, cultural heritage and economic considerations.	The proposal is not located on Crown land. The Penrith General Cemetery north of the proposal is identified as Crown land; however, no work would occur on cemetery land.
Heritage Act 1977	The *Heritage Act 1977* (Heritage Act) seeks to conserve items of environmental heritage of NSW. Relevant provisions of the Heritage Act are: — Sections 57 and 60 (approval) where items listed on the State Heritage Register would be impacted — Sections 139 and 140 (permit) where relics are likely to be exposed. For any works which may have an impact on items listed on a Section 170 heritage and conservation register maintained by a government agency, notification to Heritage NSW may be required.	There are no listed heritage items located within the proposal site. The Penrith General Cemetery north of the proposal is listed as a local heritage item under the Penrith Local Environmental Plan 2010 (Penrith LEP); however, is unlikely to be impacted. A Landscape Character and Visual Impact Assessment (LCVIA), described in Section 6.2, identified negligible impacts to area, including the cemetery, from operation of the proposal. The proposal is unlikely to impact heritage items.
National Parks and Wildlife Act 1974	The *National Parks and Wildlife Act 1974* aims to conserve nature and objects, places or features of cultural value. An Aboriginal Heritage Impact Permit (AHIP) is required for any activities likely to have an impact on Aboriginal objects or Places or cause land to be disturbed for the purposes of discovering an Aboriginal object.	A Heritage Assessment was prepared by Ozark for the proposal (refer to Appendix I). This did not identify any Aboriginal sites or places within 200 metres of the proposal site. The proposal is unlikely to impact Aboriginal heritage sites and an AHIP is not required.

Legislation	Purpose	Relevance to the proposal and approval requirements
Protection of the Environment Operations Act 1997	The *Protection of the Environment Operations Act 1997* (POEO Act) provides for issuing licences regarding environmentally hazardous activities, issuing offence notices, establishing environmental protection policies, instituting proceedings, investigating breaches and auditing activities. The Act primarily regulates pollution control and waste disposal in NSW.	The proposal does not constitute a 'scheduled activity' under Schedule 1 of the POEO Act and would not require an Environment Protection Licence. In accordance with Part 5.7 of the POEO Act, Penrith City Council would notify the NSW EPA of relevant pollution incidents that occur onsite.
Roads Act 1993	Section 138 of the *Roads Act 1993* requires approval for work to occur on or over a public road. However, Clause 5(1) in Schedule 2 of the Roads Act states that public authorities do not require consent for works on unclassified roads.	No works are proposed to be undertaken on a classified road and approval is not required under the Act. Temporary works are proposed to be carried out in Cox Avenue, Richmond Road and Park Avenue during construction and the community would be notified of any lane closures.
Transport Administration Act 1988	The *Transport Administration Act 1988* establishes Transport for NSW as a public authority that is to exercise its functions in a manner that promotes certain common objectives, including to promote the delivery of transport services in an environmentally sustainable manner.	This proposal considered the objectives of this Act for the delivery of the transport infrastructure. Transport for NSW was consulted during development of the proposal (refer Section 5.1.2).
Waste Avoidance and Resource Recovery Act 2001	Objects of the *Waste Avoidance and Resource Recovery Act 2001* include encouraging efficient use of resources and reducing environmental harm in accordance with the principles of Ecologically Sustainable Development. The Act establishes the waste hierarchy of avoidance, resource recovery and disposal.	Waste management is discussed in Section 6.10. A site-specific Waste Management Plan would be prepared as part of the CEMP to address potential waste issues and mitigation measures to reduce impacts.
Water Management Act 2000	The *Water Management Act 2000* (WM Act) aims to provide for the sustainable and integrated management of water sources of the state for the benefit of both present and future generations. The proposal is located within the boundary of the Greater Metropolitan Region Unregulated River Water Sources Water Sharing Plan and the provisions of the WM Act apply. Works within 40 metres of a waterway generally require a Controlled Activity Approval (Section 91).	The proposal would not involve any water use (from a natural source such as aquifer or river – only from the network), water management works, drainage or flood works, controlled activities or aquifer interference. Based on the topography of the site, groundwater is anticipated to flow in the south-east towards Werrington Creek. A search on the NSW Department of Primary Industries Water (DPI Water) online map identified no registered groundwater boreholes within 500 metres of the proposal site (Douglas Partners, 2021).

Legislation	Purpose	Relevance to the proposal and approval requirements
	A licence for the extraction and use of groundwater may be required in accordance with the water sharing plan.	The PSI undertook environmental fieldwork including drilling and soil sampling from boreholes at a maximum depth of 7 metres. The PSI found no free groundwater during auguring. It is understood that groundwater would not be intercepted during construction. Mitigation measures outlined in Section 6.8.3 would be implemented in the unlikely event groundwater is encountered. Approval is not required under this Act.

4.3 State environmental planning policies

The following SEPPs are relevant to the proposal or the land on which the proposal would be built.

4.3.1 State Environmental Planning Policy (Transport and Infrastructure) 2021

The Transport and Infrastructure SEPP guides the delivery of key infrastructure across the State. It determines the permissibility of an activity or development and the part of the EP&A Act under which it may be assessed. The Transport and Infrastructure SEPP prevails over most other EPIs to the extent of any inconsistency including LEPs.

Division 15, Clause 2.91 of the Transport and Infrastructure SEPP permits 'development for the purpose of a railway or rail infrastructure facilities' to be carried out by or on behalf of a public authority without consent on any land. Clause 2.90 defines 'rail infrastructure facilities' as including 'associated public transport facilities for railway stations' which is further defined in Clause 2.3 to include 'car parks intended for use by commuters.'

As the proposal is a commuter car park carried out by Penrith City Council, it does not require development consent and can be assessed under Part 5 of the EP&A Act.

The Transport and Infrastructure SEPP prescribes consultation to be undertaken with the Council and the relevant public authorities for this proposal. Furthermore, under Schedule 3 of the Transport and Infrastructure SEPP, car parks with 200 or more car parking spaces are considered 'traffic-generating development' and should be referred to Transport for NSW (see Section 5.2). Consultation that has occurred is described in Section 5.2.

4.3.2 State Environmental Planning Policy (Precincts—Western Parkland City) 2021

The Western Parkland City SEPP provides provisions for the planned Western Parkland City and the associated State Significant Precincts. The proposal site is on the edge of the prescribed Obstacle Limitation Surface specified in this SEPP for airspace operations associated with the proposed Aerotropolis. The Obstacle Limitation Surface height applicable to the proposal is 230.5 metres Australian height datum (AHD). As the proposed multi-storey commuter car park is on land between around 49.6 metres and 52.5 metres AHD and would be a maximum height of approximately 16 metres, the proposal is more than 150 metres from interacting with the Obstacle Limitation Surface.

4.3.3 State Environmental Planning Policy (Resilience and Hazards) 2021

The Resilience and Hazards SEPP provides a State-wide planning approach to remediation of contaminated land, including identifying when consent is required. Clause 4.8 of Resilience and Hazards SEPP defines Category 1 remediation as remediation work that requires development consent. However, the proposed development would be carried out under Transport and Infrastructure SEPP and contamination is addressed in Section 6.8. The PSI considered that Lot 1 DP198211 can be made suitable for the proposed development subject to further investigation for volatile organic compounds from the clearing chemicals warehouse immediately west of the site (see Section 6.8 for further detail).

4.4 Local environmental plans

4.4.1 Penrith City Council Local Environmental Plan 2010

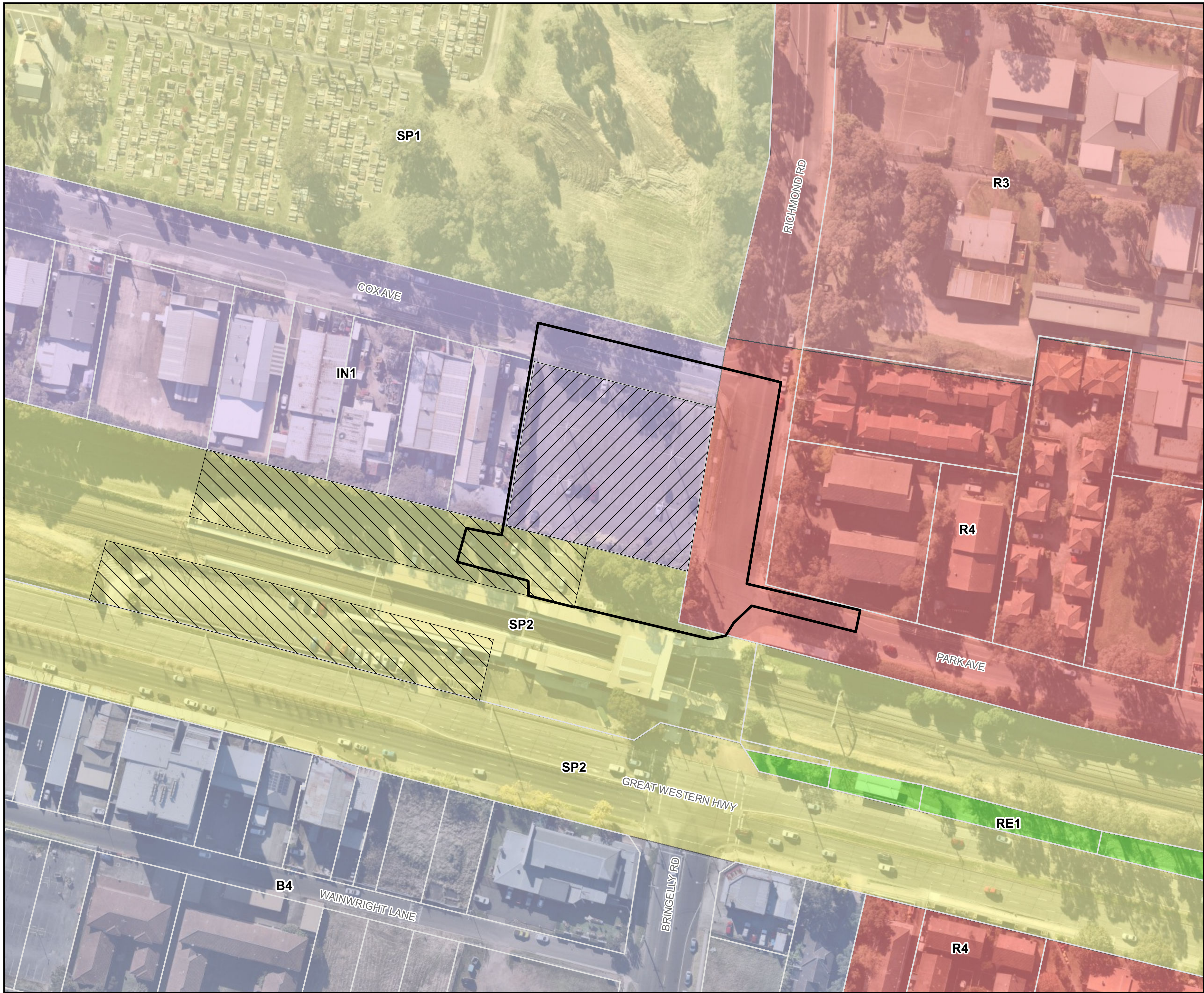
The proposal is located within land subject to provisions of the Penrith LEP. The proposal site is zoned IN1 General Industrial, SP2 Infrastructure and R4 High Density Residential (refer Figure 4.1).

As the proposal is permissible without consent, provisions of Penrith LEP are not applicable. Notwithstanding, relevant provisions of the Penrith LEP are addressed in Table 4.3.

Table 4.3 Relevant provisions of the Penrith LEP

Clause	Provision	Consistency of the proposal
Clause 2.3 – Zone objectives and Land Use Table	Objectives of the IN1 General Industrial zone are to: — provide a wide range of industrial and warehouse land uses — encourage employment opportunities — minimise any adverse effect of industry on other land uses — support and protect industrial land for industrial uses — promote development that makes efficient use of industrial land — permit facilities that serve the daily recreation and convenience needs of the people who work in the surrounding industrial area.	The car park would be located in and consistent with the objectives of IN1 zone as it would encourage employment opportunities and permits facilities that serve the daily recreation and convenience needs of people who work in the surrounding industrial area by providing commuter car parking.
	Objectives of the SP2 Infrastructure zone are to: — provide for infrastructure and related uses — prevent development that is not compatible with or that may detract from the provision of infrastructure.	Landscaping and road integration works are proposed within the Transport for NSW car park on land zoned SP2. No change to land use is proposed in this zone. The proposal supports existing rail infrastructure by providing commuter car parking.
	Objectives of the R4 High Density Residential zone are to: — provide for the housing needs of the community within a high density residential environment. — provide a variety of housing types within a high density residential environment. — enable other land uses that provide facilities or services to meet the day to day needs of residents. — ensure that a high level of residential amenity is achieved and maintained. — encourage the provision of affordable housing. — ensure that development reflects the desired future character and dwelling densities of the area.	The proposal would require utility works along Cox Avenue, Richmond Road and Park Avenue to support the multi-storey commuter car park. No change to land use is proposed in this zone. The proposed car park would remove cars from parking in the street and therefore improve the local amenity and visual aesthetic of the area.

Clause	Provision	Consistency of the proposal
Clause 4.3 – Height of buildings	Objectives of this clause are to: — ensure that buildings are compatible with the height, bulk and scale of the existing and desired future character of the locality — minimise visual impact, disruption of views, loss of privacy and loss of solar access to existing development and to public areas, including parks, streets and lanes — minimise the adverse impact of development on heritage items, heritage conservation areas and areas of scenic or visual importance — nominate heights that will provide a high quality urban form for all buildings and a transition in built form and land use intensity. The height of a building on any land is not to exceed the maximum height shown for the land on the Height of Buildings Map.	Based on the Penrith LEP Height of Buildings Map, the maximum allowable height in the proposal site is 12 metres. The proposed car park structure would be approximately 14 metres high with the lift shaft reaching a height of approximately 16 metres. Clause 2.7 of the Infrastructure SEPP provides that (with limited exceptions) the Infrastructure SEPP prevails over all other EPIs (including the Penrith LEP and associated development controls). Accordingly, the proposal remains permissible without development consent. The LCVIA (Appendix E) found that while the car park would be large scale, the architectural treatment and proposed landscape works, as well as the vertical plantings on the facade, would improve this view and general appearance of the car park. The car park structure would be absorbed into the setting of other larger scale built forms in the area.
Clause 7.5 – Protection of scenic character and landscape values	The objectives of this clause are to: — identify and protect areas that have particular scenic value either from major roads, identified heritage items or other public places — ensure development in these areas is located and designed to minimise its visual impact.	The proposal is not located within a scenic character area and therefore does not hold landscape values. Landscape character and visual amenity is discussed further in Section 6.2.
Claus 7.4 – Sustainable Development	The objectives of this clause are to consider the following: — conserving energy and reducing CO^2 emissions — embodied energy in materials and building processes — building design and orientation — passive solar design and day lighting — natural ventilation — energy efficiency and conservation — water conservation and water reuse — waste minimisation and recycling — reduction of vehicle dependence — potential for adaptive reuse.	The proposal considers sustainable development including the implementation and design of solar panels, electric vehicle parking stations, green walls and landscaping once constructed. Sustainability initiatives are outlined further in Section 6.12.



Kingswood Commuter Car Park

Figure 4.1
Land Zoning Across the Proposal Site

Legend

- Cadastre
- Proposal Site
- Council at-grade car park
- Transport for NSW car park

Land Zone

- B4 Mixed Use
- IN1 General Industrial
- R3 Medium Density Residential
- R4 High Density Residential
- RE1 Public Recreation
- SP1 Special Activities
- SP2 Infrastructure

0 20 40 Meters

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

1:1,200 Date: 13/07/2022

Data sources: - DNRME, TMR, Translink, Geoscience Australia

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4.5 Ecologically sustainable development

The principles of Ecologically Sustainable Development (ESD) are generally defined under the provisions of clause 193 the EP&A Regulation as:

- The precautionary principle – if there are threats of serious or irreversible damage, a lack of full scientific uncertainty should not be used as a reason for postponing measures to prevent environmental degradation.
- Intergenerational equity – the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.
- Conservation of biological diversity and ecological integrity – the diversity of genes, species, populations and their communities, as well as the ecosystems and habitats they belong to, should be maintained or improved to ensure their survival.
- Improved valuation, pricing and incentive mechanisms – environmental factors should be included in the valuation of assets and services.

In line with Council's Sustainable Building Design Checklist 2021, the car park would adopt a Green Urbanisation approach, where practicable, including vertical garden walls, and solar panels to offset the cost of electricity. This would be dependent upon funding and future design refinements. The key sustainability initiatives proposed to be implemented include:

- vertical plantings on the facade, selected with consideration of the proposed design and species to suit western Sydney's climate
- rainwater tanks for landscape irrigation and toilet flush
- water efficient systems and fixtures
- solar panels on the rooftop
- energy efficient LED lighting
- consider the Life Cycle of all materials – select materials with a low embodied energy, that are durable, low maintenance, have a recycled content, that can be recycled, that have buy back or reuse schemes
- all concrete would have a recycled content and use recycled aggregate wherever practicable.

4.6 Confirmation of statutory position

Subject to the provisions of Transport and Infrastructure SEPP, the proposal does not require development consent and is permitted without consent under Part 5 (Division 5.1) of the EP&A Act. Penrith City Council is the proponent and determining authority for the proposal.

This REF fulfils Penrith City Council's obligation under Division 5.1, Section 5.5 of the EP&A Act to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity.

It is understood that further refinement of the design is occurring. A consistency assessment would be prepared to confirm that the final proposal is consistent with this REF and to determine if additional investigations and/or an addendum REF are required.

5 Community and stakeholder engagement

5.1 Stakeholder consultation during concept design

5.1.1 Penrith City Council

Penrith City Council is the proponent and the determining authority for this proposal.

5.1.2 Transport for NSW

As the proposed works are partially located within Transport for NSW land and would provide car parking for commuters accessing Kingswood Station, Transport for NSW were consulted during development of the proposal. A meeting to discuss the proposal was held with the Transport for NSW Configuration Control Board on 15 July 2022. The meeting involved raising technical considerations and commencing the process of confirming an interface agreement for the works proposed on Transport for NSW land.

5.1.3 Sydney Trains

As the proposed works are located adjacent to the rail corridor, Sydney Trains were consulted during development of the proposal. A meeting to discuss the proposal was held with the Sydney Trains Station Working Group on 3 May 2022. The meeting addressed Sydney Trains customer focussed issues with continued consultation on particular issues arising from that meeting.

5.2 Consultation under the Transport and Infrastructure SEPP

Division 1, clauses 2.10 to 2.16 of the Transport and Infrastructure SEPP specify the requirements for consultation with councils and other public authorities for infrastructure development carried out by or on behalf of a public authority. Under Clause 2.17 (c) Council is the proponent and consultation with Council is not required.

As the proposal involves an additional capacity of over 300 car parking spaces it would be considered 'traffic-generating development' under Schedule 3 of the Transport and Infrastructure SEPP. In accordance with Clause 2.121, there is a requirement to provide notification to Transport for NSW of the proposal. There is also a requirement to provide a copy of the determination to Transport for NSW within seven days of the determination.

The proposal is partially within the Sydney Trains Corridor Protection Zone and construction would occur adjacent to the rail corridor. In accordance with Clause 3.12 of the Transport and Infrastructure State Environmental Planning Policy 2021, there is a requirement to provide notification to Sydney Trains about the proposal.

Transport for NSW and Sydney Trains were consulted during development of the proposal as described in Section 5.1. Furthermore, Transport for NSW and Sydney Trains were formally notified of the proposal in accordance with the Transport and Infrastructure SEPP through an email dated 20 July 2022.

5.3 Community consultation

5.3.1 Community consultation

A Stakeholder Engagement and Communication Plan was prepared by WSP on behalf of Penrith City Council in May 2022 to support development of the REF. The strategy primarily focused on properties in the immediate surrounds of the proposal site. The key consultation activities that will occur during exhibition of the REF include:

- doorknock and letterbox drop completed for nearby residents and local businesses
- meeting with nearby stakeholders including Penrith General Cemetery, St Joseph's Church and St Joseph's Primary School
- advertise Kingswood Car Park web page on Council's website and Your Say website through posters within the car park.

5.4 Public display of the REF

The REF would be placed on public display on the Penrith City Council website for two weeks starting from the end of July 2022. The public would be invited to read and provide submissions on the proposal during this exhibition period.

6 Environmental impact assessment

Chapter 6 of the REF provides a detailed description of the likely environmental impacts associated with construction and operation of the proposal. For each environmental impact, the existing environment is characterised and then an assessment is undertaken as to how the proposal would impact on the existing environment. Mitigation measures are proposed to ameliorate potential environmental impact during construction and operation.

6.1 Traffic and transport

A Traffic Impact Assessment (TIA) was prepared by Northrop Consulting Engineers Pty Ltd for the proposal (see Appendix D). The results of the assessment are summarised in this section.

6.1.1 Existing environment

6.1.1.1 Road network

The proposal site is located on Cox Avenue, Richmond Road and Park Avenue which are all two lane local roads with 50 kilometre per hour (km/hr) speed limits (refer to Figure 6.1). The morning peak traffic period for the intersection of Cox Avenue and Richmond Road is around 7.45 am to 8.45 am that correlates with the peak hour for users of the car parks surveyed arriving to the car park between 7:00 am to 8:00 am. The afternoon peak period has been assumed as 4.45 pm to 5.45 pm. Richmond Road is in a School Zone reducing the speed limit to 40 km/hr in the morning and afternoon on school days. Traffic counts on Richmond Road and Cox Avenue were taken between 5 to 11 May 2022 (refer Table 6.1).

Table 6.1 Traffic volumes based on traffic count between 5 and 11 May 2022

Road	Direction	Weekday average daily traffic	Weekday average AM peak hour traffic	Weekday average PM peak hour traffic
Richmond Road between existing car park driveway and Cox Avenue	North	763	62	69
	South	771	81	67
Cox Avenue between existing car park driveway and Cox Avenue	East	506	39	55
	West	1,072	116	83

Existing traffic accident data for Cox Avenue and Richmond Road between 2016 and 2020 was obtained from the NSW Government Transport for NSW Centre for Road Safety Website on 17 May 2022. There are only five recorded incidents along the key roads of Cox Avenue and Richmond Road. The available accident data does not represent any ongoing issues to be addressed through development of the proposal; however, Penrith City Council would monitor the area and address safety concerns should they arise.

There are five key intersections within the vicinity of the proposal:

- Cox Avenue and Richmond Road
- Parker Street and Copeland Street
- Copeland Street and Phillip Street
- Copeland Street and Heath Street
- Victoria Street and Heath Street.

Each intersection was assessed using SIDRA Intersection 9 software against the following factors:

- Degree of Saturation (DoS) – ratio of arrival (demand) flow rate to capacity of the intersection during a given flow period. Acceptable intersection performance requires a DoS less than 1.0
- Level of Service (LoS) – an index (A to F) of the operational performance of traffic at an intersection during a given flow period. Acceptable intersection performance requires a minimum of LoS D
- average vehicle delay – delay experienced by a vehicle crossing a signalised intersection.

Intersection	Highest DoS	Highest LoS	Highest avg. vehicle delay (secs)
Cox Avenue and Richmond Road — currently has free flowing conditions with minimal delays or queuing	0.078	A	4.9
Parker Street and Copeland Street — considered satisfactory	0.924	F	71.0
Copeland Street and Phillip Street — currently has free flowing conditions with minimal delays or queuing	0.597	A	9.9
Copeland Street and Richmond Road — currently has free flowing conditions with minimal delays or queuing	0.588	A	9.8
Victoria Street and Heath Street — currently has free flowing conditions with minimal delays or queuing	0.180	A	11.4

A kiss and ride shelter for Kingswood Station is located on Richmond Road where it meets Park Avenue to facilitate pick up of commuters from Kingswood Station. A kiss and ride facility is also available on the southern side of Kingswood Station off the Great Western Highway.

6.1.1.2 Parking

The proposal site is currently used as an existing commuter car park providing at-grade parking for commuters using the rail network as well as parking for those accessing local businesses. The existing commuter car park provides around 114 car parking spaces and there are two adjacent Transport for NSW car parks (north and south of Kingswood Station) that provide a total of around 148 car parking spaces (refer to Figure 6.1).

On-street parking is available on neighbouring streets. This parking is generally untimed.

Kingswood Commuter Car Park

Figure 6.1
Transport Network

Legend

- Bus Stop
- Kiss and Ride
- Train Station
- Cadastre
- Proposal Site
- Council at-grade car park
- Transport for NSW car park

0 20 40 Meters

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

1:1,200 Date: 13/07/2022

Data sources: - DNRME, TMR, Translink, Geoscience Australia

6.1.1.3 Public transport

The proposal site is located adjacent to the rail corridor and Kingswood Station. Kingswood Station is located on the Main Western Line and is serviced by T1 Western Line train services. Kingswood Station can be accessed by pedestrians from Park Avenue where it meets Richmond Road. Local bus stops are located at the following locations:

- St Joseph's Primary School, Richmond Road
- Park Avenue (opposite Kingswood Station)
- Kingswood Station
- Kingswood station, Great Western Highway
- Great Western Highway (opposite Kingswood Station).

The bus stops service the N70 bus route (between Penrith and Townhall), 4000 bus route (between Minchinbury and Llandilo), 4113 bus route (services from Kingswood Station (south side) to Kingswood Public School) and 4149 bus route (between Kingswood Station (north side) to St Joseph's Primary School).

6.1.1.4 Active transport

Footpaths in the vicinity of the proposal site are located on:

- both sides of Richmond Road
- the southern side of Cox Avenue
- the northern side of Park Avenue.

No dedicated cycling paths are located near the proposal site. Bike racks are located on the southern and northern side of Kingswood Station.

6.1.2 Potential impacts

6.1.2.1 Construction

Parking

Construction of the proposal would result in the temporary loss of around 125 existing commuter car spaces within the proposal site, comprising of around 114 spaces in the existing Kingswood commuter car park and around 11 car parking spaces in the northern Transport for NSW car park. This temporary loss of car parking spaces during construction is expected to have a temporary impact on parking availability for commuters. During site establishment, an access to the northern Transport for NSW car park would be constructed in order to maintain access to around 70 car parking spaces for commuters prior to closure of the existing Kingswood commuter car park for construction.

In addition to retaining car parking spaces for commuters north of Kingswood station through a new access into the Transport for NSW car park, the Transport for NSW commuter car park south of Kingswood station would also remain open during construction. As a result, there would be around 136 commuter car park spaces available throughout the construction phase of the project.

The construction workforce for the proposal would include a peak workforce of around 70 workers over the 12 month construction phase. On average, there would be about 15 workers in off-peak periods. Staff parking has the potential to further absorb the parking spaces in the vicinity and impact the availability of parking spaces for commuters. A Construction Traffic Management Plan (CTMP) would be prepared as part of the CEMP and implemented during construction to minimise impact from construction worker parking on commuters.

Road network

The proposal site would be primarily accessed via Richmond Road and Park Avenue. The proposal would include additional heavy and light vehicles using the surrounding road network to allow for the construction worker vehicles and transfer of materials. Construction works would generate two to ten truck movements per hour across the construction program and 30 to 50 truck movements daily during peak activities (around a six to eight week period).

Construction of the proposal would result in a minor increase in traffic on the surrounding roads as a result of the following:

- delivery of construction materials
- delivery and removal of construction equipment and machinery
- movement of construction personnel.

Temporary works are proposed to be carried out in Cox Avenue, Richmond Road and Park Avenue during construction and the community would be notified of any lane closures. Traffic management would likely be required on Richmond Road and Park Avenue during deliveries using heavy vehicles and services and utility connection work within the road reserve. At these times, road users may need to wait to allow trucks to enter the proposal site safely. Traffic management measures would maintain access for emergency vehicles. Access to the properties near the proposal would be maintained.

The kiss and ride on Richmond Road would be relocated a short distance north of its existing location during site establishment works to allow for unobstructed access to the kiss and ride amenity of Kingswood Station. There are no changes proposed to the kiss and ride on the southern side of Kingswood Station.

Public transport

The bus stop on Park Avenue would not be directly impacted by constriction. However, traffic management along Park Avenue and Richmond Road may result in minor delays to buses during construction.

Active transport

The footpaths within the proposal site would be temporarily disrupted during construction. Access to Kingswood Station for pedestrians would be maintained throughout construction.

6.1.2.2 Operation

Parking

The key objective of the proposal is to provide an increased number of commuter car parking spaces. The multi-storey commuter car park would provide a minimum of 410 commuter car parking spaces at Kingswood Station. The proposal requires the removal of around 114 at-grade parking spaces to be replaced by the proposed multi-storey commuter car park, therefore resulting in around 300 additional car parking spaces at the proposal site subject to ongoing refinement of the design. The proposal would prevent parking overspill into neighbouring areas and provide greater opportunities for commuters to use public transport.

Road network

Access to the proposed car park would be via two vehicular access and egress points on Cox Avenue and Richmond Road. The proposal would maintain the restricted service access corridor to the Transport for NSW at-grade car park to promote a pedestrian friendly environment through the provision of a landscape corridor. The proposal is predicted to generate an additional 102 trips during the morning and afternoon peak times during the week.

Five intersections were modelled for operating conditions taking into account the increased traffic generation up to the year 2033, and the results are summarised in Table 6.2.

Table 6.2 Key intersection performance during operation up to the year 2033

Intersection	Operation
Cox Avenue and Richmond Road	The intersection performance would experience negligible change when compared to existing conditions. The highest DoS would be 0.143, however, the intersection would maintain an LoS of A, as it is predicted to remain free flowing with minimal delays or queuing up to 2033.
Parker Street and Copeland Street	The intersection performance would decrease, however, the major contribution to this would be from future traffic growth rather than the proposal. The highest DoS would be 1.203 with an LoS of F and would be considered to be operating over capacity in 2033 with the exiting intersection already operating near capacity.
Copeland Street and Phillip Street	The intersection performance would decrease, however, the major contribution to this would be from future traffic growth rather than the proposal. The highest DoS would be 0.820, however the intersection would maintain an LoS of A, and is predicted to be good with acceptable delays and spare capacity up to 2033.
Copeland Street and Richmond Road	The intersection performance would decrease, however, the major contribution to this would be from future traffic growth rather than the proposal. The highest DoS would be 0.792, however the intersection would maintain an LoS of A, and is predicted to be good with acceptable delays and spare capacity up to 2033.
Victoria Street and Heath Street	The intersection performance would experience negligible change when compared to existing conditions. The highest DoS would be 0.347, however the intersection would maintain an LoS of A, as it is predicted to remain free flowing with minimal delays or queuing up to 2033.

Public transport

No changes to bus or train operations are predicted as a result of the proposal. The additional commuter car parking would likely result in an increased number of commuters using Kingswood Station. Longer private vehicle trips to major employment areas, such as the Sydney central business district, may be reduced through the uptake of public transport. The new parking facilities would help to encourage more people to use public transport.

Active transport

The proposal would not change the layout of pedestrian infrastructure along Park Avenue, Richmond Road, and Park Avenue. Bicycle storage would be provided as part of the proposal.

6.1.3 Mitigation measures

The proposed mitigation measures are outlined in Table 6.3.

Table 6.3 Traffic mitigation measures

ID	Mitigation measure	Stage
T1	A Construction Traffic Management Plan (CTMP) will be prepared as part of the CEMP and implemented during construction. The CTMP will be developed in consultation with Penrith City Council and Transport for NSW and include at a minimum: — adequate signage to inform motorists and pedestrians of the work site and the change in road conditions — maximising safety and accessibility for pedestrians and cyclists — ensuring adequate sight lines to allow for safe entry and exit from the site — traffic controls to manage deliveries — management of the temporary kiss and ride on Richmond Road — ensuring access is maintained to Kingswood Station and the adjacent Transport for NSW car park — parking locations for construction workers away from the station and promotion of use of public transport by workers and details of how this would be monitored for compliance — required regulatory and direction signposting, line marking and variable message signs and all other traffic control devices necessary for the implementation of the CTMP. For surrounding projects that may be under construction concurrently with the proposal, consultation will also be undertaken with the proponent(s) to consider opportunities to reduce cumulative impacts of construction traffic. The performance of all project traffic arrangements must be monitored during construction.	Pre-construction/ Construction
T2	Penrith City Council will monitor the performance of the following intersections to determine if intersection modifications are required post construction of the Kingswood commuter car park based on safety concerns, additional development in the area or any other determining factors: — Cox Avenue and Richmond Road — Copeland Street and Phillip Street — Copeland Street and Richmond Road — Victoria Street and Heath Street, Parker Street and Copeland Street intersection requires further assessment by Penrith City Council for traffic not generated by the proposal, as the traffic impact assessment found that the intersection would be operating over capacity in 2033 from predicted traffic growth.	Operation
T3	Penrith City Council will monitor the key roads during operation of the Kingswood commuter car park to determine whether: — the speed limit is suitable for the environment with during operation of the proposal — additional infrastructure is required to assist vehicular and pedestrian movements along and across the key roads adjacent the proposal.	Operation
T4	Penrith City Council will provide a copy of the determination to Transport for NSW within seven days of the determination.	Operation

6.2 Landscape and visual

A LCVIA was prepared by Iris Visual Consulting (Appendix E) and a Lighting Impact Assessment was prepared by WSP (Appendix F). The results of the assessments are summarised in this section.

6.2.1 Existing environment

The proposal site is located predominately on land zoned as IN1 General Industrial and is currently used as an at-grade commuter car park. The proposed shared access road is within land zoned SP2 Infrastructure and the access from Richmond Road is within R4 High Density Residential.

Sensitive visual receivers within include the following:

- residential receivers located directly east of the proposal site
- non-residential receivers, including commercial premises and educational receivers
- road users and pedestrians on Park Avenue, Richmond Road, and Cox Avenue and town centre
- commuters using Kingswood Station
- Penrith General Cemetery.

Other nearby facilities include the Nepean Hospital and medical precinct to the south-west of the site on the south side of Kingswood Station. The Western Sydney University Campus is located to the south-east of the subject site and on the southern side of the Kingswood Station.

6.2.1.1 Viewpoints

Four viewpoints were selected from publicly accessible locations to illustrate the visual influence of the proposal (refer to Figure 6.2 and Figure 6.3). These views include:

- Viewpoint 1: this view south-west from Richmond Road directly captures the at-grade commuter car park in the middle ground. Kingswood Station can be seen glimpsed through the trees, to the south, including the station footbridge, lifts and stairs. Several taller apartment buildings, to the south of the station can be seen in the background.
- Viewpoint 2: this view south-east from Penrith General Cemetery and south-west from Richmond Road directly captures the at-grade commuter car park in the middle ground. The two and three storey brick apartments and townhouses along the eastern side of Richmond Road are visible in the background. The mature trees within the cemetery, along Richmond Road and at the southern end of the car park give this view a leafy character.
- Viewpoint 3: this view west from Park Avenue captures the bus stop and kiss and ride zone in the foreground with the at-grade car park visible to the north. Low-rise industrial buildings are visible in the background. The mature trees around Kingswood Station, along with vegetation in the cemetery provide a somewhat leafy character to this view.
- Viewpoint 4: this view north-east from the commercial area along the Great Western Highway. The station structures, particularly the canopy structures and footbridge, and cars in the southern commuter car park, partially block views to the proposal site from this location.

Kingswood Multi-Storey Commuter Car Park

Figure 6.2
Viewpoint Location

Legend

- Viewpoint Location
- Cadastre
- Proposal Site

0 20 40 Meters

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

1:1,200 Date: 14/07/2022

Data sources: - DNRME, TMR, Translink, Geoscience Australia

Viewpoint 1 – view south-west from Richmond Road

Viewpoint 2 – view south-east from Penrith General Cemetery

Viewpoint 3 – view west from Park Avenue

Viewpoint 4 – view north-east from great western highway

Figure 6.3 Photos from the viewpoints looking towards the proposal site

6.2.1.2 Night-time and lighting

The proposal site is within an area of medium district brightness with a low visual sensitivity due to the brightly lit streets, car park areas, Kingswood Station, as well as the surrounding low to medium density residential development.

Kingswood Station is brightly illuminated to meet the relevant Australian standards (or other applicable guidelines) at the time of installation. The existing at-grade car park lighting (and the streetlights directly surrounding the car park) spill onto Richmond Road and Cox Avenue. There is a brightly lit pathway to the station from the corner of Park Avenue and Richmond Road, which results in light spill on the residential properties of 8–10 Richmond Road, and 80 Park Avenue.

6.2.2 Potential impacts

6.2.2.1 Construction

Construction activities would result in some short-term impacts on the visual amenity for nearby receivers due to the presence of construction vehicles and equipment, temporary safety screens and fences, storage of construction equipment and plant, materials stockpiling and the presence of incomplete structures. Construction of the upper levels of the car park would be visible above the fence line, gradually rising to five levels in height.

During construction, the proposal site would be lit for security. However, it is unlikely that the site would be used on an ongoing basis for construction activity during evening hours. Generally, the character of any construction works at night would be visually absorbed into the surrounding brightly lit urban environment. Night-time construction would require approval from Council, community consultation and consideration of this REF.

Overall, the potential visual impacts of construction activities are considered to be moderate-low to low during construction as the works would be temporary and short-term. Impacts would be minimised using the mitigation measures outlined in Section 6.2.3.

6.2.2.2 Operation

Landscape character and visual amenity of the car park during operation would be influenced by the height and bulk of the structure, removal of some vegetation, and proposed landscaping and building design.

Vertical plantings on the façade of the car park would make it more appealing to residents and the community using the area. The car park structure would be enclosed by folded steel mesh panels, which would provide visual interest, reduce the visual bulk of the structure and filter views to vehicles located within the car park. There would be new landscaping between the multi-storey car park and Kingswood Station as well as new street trees along Richmond and Cox Avenue. This would improve the visual appearance of the streetscape and the approach to the station entrance.

Viewpoints

The impact assessment of each viewpoint is summarised in Table 6.4. The viewpoints have been assessed generally in accordance with the NSW Roads and Maritime Services' Guideline for Landscape Character and Visual Impact Assessment, Environmental Impact Assessment Practice Note EIA-N04 (RMS, 2018) and the Guidance Note for Landscape and Visual Assessment (Australian Institute of Landscape Architects [AILA], 2018). The method to measure impact is based on the combination of sensitivity of the existing view to change, and magnitude of change on that area or view by the proposal. Sensitivity refers to the qualities of an area, the number and type of receivers and how sensitive the existing character of the setting is to the proposed nature of change. Magnitude refers to the physical scale of a project, how distant it is and the contrast it presents to the existing setting.

Table 6.4 Viewpoint impact assessment

Viewpoint	Sensitivity	Description of change	Magnitude of change	Visual impact
Viewpoint 1: View south-west from Richmond Road	Low	While the car park structure would be large scale, the architectural treatment and proposed landscape works to the streetscape would improve this view and general appearance of the station entrance.	Negligible	Negligible
Viewpoint 2: View south-east from Penrith General Cemetery	Low	The car park structure would introduce a large scale built form that would be absorbed into the setting of other larger scale built forms. The contrast in scale would be offset by the design treatments and landscaping of proposal.	Negligible	Negligible
Viewpoint 3: View west from Park Avenue	Low	The proposal would introduce a large new structure prominently into this view. However, there is the capacity for this view to absorb this change due to its location adjacent to the larger scale Kingswood Station structures.	Negligible	Negligible

Viewpoint	Sensitivity	Description of change	Magnitude of change	Visual impact
Viewpoint 4: View north-east from Great Western Highway	Low	Part of the southern façade of the car park structure would be visible from this view. The proposal would be partially screened by the station canopy structures and remaining trees but would block vies of the existing cemetery vegetation from this viewpoint. While the leafy setting of the station would be reduced, the proposal would be seen in the context of the station and hence would be compatible with the character of the Kingswood Station.	Negligible	Negligible

Over shadowing

Figure 6.4 shows the potential worst-case overshadowing scenario that would occur during winter as a result of the proposal. Kingswood Station would experience overshadowing during winter months at different times of the day, due to the close proximity and height of the car park structure. The station platforms and northern Transport for NSW commuter car park would be shaded during the morning, while the northern station entrance, including the stairs and ramping structure would be shaded in the afternoon. The majority of the open space located between the station and car park structure would be shaded during winter months.

The dwellings to the east of the site, at 2–10 Richmond Road, would not experience overshadowing during winter months.

Figure 6.4 Potential overshadowing on 21 June at 9.00 am, noon and 3.00 pm

Night-time and Lighting

During operation, the multi-storey commuter car park and adjacent public domain would be brightly lit at night for safety in line with the CPTED. This would include motion sensor lighting as required inside the car park, and lighting of the footpaths, and streets surrounding the structure.

The new car parking structure would be seen within the context of the existing brightly lit Kingswood Station and existing street lights along adjacent streets. The proposal would extend this brightly lit character closer to the residential areas to the north and east of the proposal site.

The proposal would incorporate measures to minimise light spill and prevent direct light intrusion onto surrounding properties. The barriers and mesh screen panels within the structure and on the façade, would be designed to block vehicle headlights from within the structure. It is likely that there would be some additional skyglow seen above the proposal site. The new commuter car park would increase the height and intensity of the light along Richmond Road.

Generally, the character of the proposed multi-storey car park would result in a low magnitude of change in views within this locality at night, resulting in a low adverse visual impact during operation.

6.2.3 Mitigation measures

Measures to mitigate visual impacts during construction would be prepared as part of the CEMP for the proposal and would include measures to screen compounds and minimise tree removal where practicable.

The proposed mitigation measures are outlined in Table 6.5.

Table 6.5 Landscape and visual mitigation measures

ID	Mitigation measure	Stage
LV1	All permanent lighting will be designed and installed in accordance with the Penrith City Council – Public Domain Lighting Policy – PDAS 003, Transport for NSW requirements and the requirements of standards relevant to AS 1158 Road Lighting and AS 4282 Controlling the Obtrusive Effects of Outdoor Lighting.	Detailed design
LV2	The detailed design of the proposal will incorporate the Crime Prevention Through Environmental Design (CPTED) principles.	Detailed design
LV3	Worksite compounds will be screened with shade cloth (or similar material) to minimise visual impacts from key viewing locations, e.g. from the station.	Construction
LV4	Temporary hoardings, barriers, traffic management and signage will be removed when no longer required.	Construction
LV5	Graffiti will be removed in accordance with Transport for NSW's Standard Requirements.	Construction
LV6	Temporary access arrangements will be well signed and provide a visually legible route for pedestrians.	Construction
LV7	Construction equipment and activity will be consolidated to maximise the area of useable public realm where practicable.	Construction
LV8	All working areas will be maintained, kept free of rubbish and cleaned up at the end of each working day. Equipment and materials will be securely stored.	Construction
LV9	Vertical planting and landscaping will be maintained for the life of the car park.	Operation

6.3 Noise and vibration

A Noise and Vibration Assessment (NVA) was prepared by WSP (see Appendix G). The results of the assessment are summarised in this section.

6.3.1 Existing environment

The proposal site is currently used as a commuter car park for Kingswood Station and nearby workplaces or facilities. There are several sensitive receivers within close proximity to the proposal, including:

- residential receivers located directly east of the proposal site
- non-residential receivers, including commercial premises and educational receivers
- Penrith General Cemetery
- places of worship including St Joseph's Catholic Church (12 Richmond Road, Kingswood) and Kingdom Connection Ministry (16 Cox Avenue, Kingswood) were identified, however these receivers are located further away from the Proposal site and therefore the receivers identified above are more sensitive for the purpose of this assessment

— other nearby facilities include the Nepean Hospital and medical precinct approximately 500 metres to the south-west of the site on the south side of Kingswood Station. The Western Sydney University Campus is located approximately 1 kilometre to the south-east of the site and on the southern side of the Kingswood Station.

6.3.1.1 Noise monitoring

The background and ambient noise levels surrounding the proposal site were determined through a combination of unattended and attended noise surveys in accordance with the AS 1055 and the *Noise Policy for Industry* (EPA, 2017). Background noise monitoring locations were selected to be representative of the sensitive receivers with the potential to be impacted by noise from construction of the proposal.

Attended noise monitoring was undertaken in May 2022 at 8–10 Richmond Road, Kingswood to identify noise sources within the area. Noise sources observed were traffic between 65 to 72 dBA, train pass-bys approximately 56 dBA and train horns of 68 dBA. Distant traffic noise was observed in the background.

The unattended noise monitoring took place between April and May 2022 at Cox Avenue and Rodgers Street. The Rating Background Level (RBL) was determined from the measurement of 10th percentile min L_{A90} noise level recorded over all day, evening and night time monitoring periods. The ambient noise levels were determined using the overall noise level over each assessment period (daytime/evening/night time) as defined in the *Noise Policy for Industry* (NPfI) (EPA, 2017) and *Interim Construction Noise Guideline* (ICNG) (Department of Environment and Climate Change [DECC], 2009). A summary of these results is shown in Table 6.6.

Table 6.6 Summary of unattended noise monitoring levels

Location	Rating Background Level (RBL) dBA[1]			Ambient noise levels dBA L_{eq}[2]		
	Day[3]	Evening[3]	Night[3]	Day[3]	Evening[3]	Night[3]
NM01	45	45	38	58	54	52
NM02	44	45	40	56	53	49

(1) Rating Background Level (RBL), the 10th percentile min L_A90 noise level recorded over all day, evening and night time monitoring periods

(2) Ambient noise levels: the overall noise level over each assessment period (daytime/evening/night time) as defined in the NPfI and ICNG

(3) Time periods defined as – Day: 7.00 am to 6.00 pm Monday to Saturday, 8am to 6pm Sunday; Evening: 6.00 pm to 10.00 pm; Night: 10.00 pm to 7.00 am Monday to Saturday, 10.00 pm to 8.00 am Sunday.

A traffic noise assessment was undertaken to assess existing noise levels along Richmond Road. The measured traffic noise levels are presented in Table 6.7.

Table 6.7 Measured traffic noise levels

Measurement location	Period	dBA $L_{eq,1hour}$[1]
NM01	Day (7.00 am to 10.00 pm)	60
	Night (10.00 pm to 7.00 am)	55

(1) 2.5 dB correction added to represent at façade noise level

6.3.1.2 Receivers

Receivers have been categorised geographically into Noise Catchment Areas (NCAs) based on similar noise environments for the purpose of assessment. Receivers are assessed in terms of their land use types as these are assigned differing noise and vibration criteria.

The NCAs are described and minimum distances to nearby sensitive receivers outlined in Table 6.8. Figure 6.5 outlines the location of the proposal, NCAs, noise monitoring locations and the nearest representative noise sensitive receivers.

Table 6.8 Noise catchment areas and classification of representative receivers

NCA	Receiver ID	Representative noise sensitive receivers	Receiver type	Minimum distance to proposal [1]
1	R1	8 Cox Avenue, Kingswood	Commercial	5 metres west of site
1	R2	27 Cox Avenue, Kingswood (Penrith Cemetery)	Passive Recreation	25 metres north of site
1	R3	115 Joseph Street, Kingswood	Residential	180 metres north of site
1	R4	12 Richmond Road Kingswood (St Joseph's Primary School)	Educational	90 metres north-east of site
1	R5	75 Park Avenue, Kingswood	Residential	35 metres east of site
2	R6	180 Great Western Highway, Kingswood	Commercial	90 metres south of site
2	R7	6 Rodgers Street, Kingswood	Residential	210 metres south of site

(1) Minimum distance of the sensitive receiver buildings to the limits of the construction footprint.

Kingswood Commuter Car Park

Figure 6.5
Project location and sensitive receptors

Legend

- Cadastre
- Proposal Site
- Council at-grade car park
- Transport for NSW car park
- Noise Catchment Area

Buildings

- Cemetry
- Commerical
- Educational Institutions
- Industrial
- Residential
- Place of Worship

0 50 100 Meters

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

1:3,031 Date: 13/07/2022

Data sources: - DNRME, TMR, Translink, Geoscience Australia

6.3.2 Potential impacts

The NVA used scenarios comprising typical plant and equipment which was developed based on indicative staging information. Construction stages and duration are presented in Table 4.1 of Appendix G.

6.3.3 Working hours

Construction work is anticipated to commence in the start of quarter two of 2023 and take place over a period of approximately 12 months.

Works would generally be undertaken during standard hours; however, certain works may need to occur outside standard hours to maintain a safe work environment or to minimise impacts to operational transport infrastructure and services. Works outside standard hours would require approval from Council and would require further assessment.

6.3.3.1 Construction noise assessment

The predicted noise levels during construction of the proposal are presented in Table 6.9, which outlines the noise level within each NCA for each representative receiver type. The ICNG provides a framework to consider the impacts of construction noise on residences and other sensitive land uses. The Noise Management Levels (NML) provide noise criteria for construction for standard construction hours and out of hours (OOH) works.

The noise levels presented in this assessment are conservative, with noise sources assumed to operate simultaneously. In reality, noise impacts are likely to be lower as plant items would not be operating simultaneously at all times and therefore it would be likely that the predicted noise levels would be reduced for some receivers.

Table 6.9 indicates that the predicted construction noise levels at the nearby residential receivers would typically exceed the standard hours NML throughout the construction period. The worst case exceedance of NMLs at a residential receiver would be up to 31 dBA.

The nearest residential receiver (R4) is predicted to be highly noise affected (experience noise greater than 75 dBA) when works occur at the closest distance to the receiver. However, it is noted that when works move further away, the receiver is generally no longer highly noise affected.

For other sensitive receivers (R1, R2, R4, and R6), the worst case construction noise levels are predicted to exceed the daytime NML for standard hours.

It is noted that a number of the scenarios incorporate plant with annoying acoustic characteristics, which have resulted in the application of a noise penalty (refer to Section 4.1.3 of Appendix G). This includes plant such as concrete saws and chainsaws, which are expected to be used very infrequently and over short periods over the construction period. It is highly unlikely that these items of equipment would be utilised on a regular basis throughout the construction works. Where these equipment are not used, noise levels would be notably decreased in their impact to receivers. This assessment addresses the impacts of both cases; however, impacts with annoying plant would be of short duration and impacts without such plant being operational are more indicative of any sustained impact over a given construction activity event.

Furthermore, noise levels presented in this assessment are conservative. Works are expected to take place intermittently over any construction period, so these exceedances would not be expected to occur continuously over the duration of the proposal.

Based on the current design and construction methodology for the proposal, noise impacts would be noticeable during standard hours at the nearest receivers to the works areas. As a result of the predicted exceedances, noise mitigation and management measures have been outlined in Section 6.3.4 to reduce potential noise impacts.

Table 6.9 Maximum predicted construction noise levels and indicative exceedances per scenario

Receiver ID[4]	Receiver type	NML (dBA $L_{eq,15min}$)				Predicted noise level per scenario, dBA $L_{eq,15min}$										
		Standard hours[1]	OOHW 1[2]	OOH 2[3]	HNA	Site establish-ment SC01	Demolition SC02		Earth works SC03	Structural works SC04	Architectural features SC05	Precinct works SC06		Testing and com-missioning SC07	Decom-missioning SC08
						Typical	Worst case	Typical	Typical	Typical	Typical	Worst case	Typical	Typical	Typical
R1	Commercial[5]	70	–	–	N/A	< 90 – 68	< 90 – 78	< 90 – 71	< 90 – 71	< 90 – 76	< 90 – 74	< 90 – 77	< 90 – 71	80 – 55	< 90 – 69
R2	Passive Recreational[5]	60	–	–	N/A	66 – 59	76 – 69	68 – 61	68 – 61	73 – 66	72 – 64	75 – 67	68 – 61	53 – 45	66 – 59
R3	Residential	55	50	43	75	60 – 51	70 – 61	62 – 53	62 – 54	67 – 58	66 – 57	69 – 60	62 – 53	47 – 38	60 – 52
R4	Educational[5]	55	–	–	N/A	66 – 44	76 – 54	68 – 46	68 – 47	73 – 52	72 – 50	75 – 53	68 – 47	53 – 31	66 – 45
R5	Residential	55	50	43	75	**76** – 66	**86** – **76**	**78** – 68	**78** – 68	**83** – 73	**81** – 72	**84** –75	**78** – 68	62 – 53	**76** – 66
R6	Commercial[5]	70	70	70	N/A	68 – 64	78 – 74	70 – 66	71 – 66	75 – 71	74 – 70	77 – 73	70 – 66	55 – 51	69 – 64
R7	Residential	54	50	45	75	61 – 51	71 – 61	63 – 53	64 – 54	69 – 58	67 – 57	70 – 60	64 – 53	48 – 38	62 – 52

(1) Time periods as defined (HNA – Highly noise affected):

a. Monday to Friday – 7.00 am to 6.00 pm, Saturday – 8.00 am to 1.00 pm and Sundays/Public Holidays

b. Saturday – 7.00 am to 8.00 am and 1.00 pm to 6.00 pm, Sunday and public holidays – 8.00 am to 6.00 pm and Monday to Saturday – 6.00 pm to 10.00 pm

c. Sunday and public holidays – 7.00 am to 8.00 am, Sunday and public holidays – 6.00 pm to 10.00 pm and All days 10.00 pm to 7.00 am

(2) Predicted noise levels include the operation of plant items with special audible characteristics (concrete saw, chainsaw)

(3) Values indicate a more typical predicted noise level where plant items with special audible characteristics are not used

(4) Receiver locations as shown in Figure 6.5

(5) Criteria apply when in use.

Out of hours

The majority of construction activities are proposed to be completed within standard construction hours. Out of hours work is not anticipated, but should it be required to minimise disruptions to commuters, pedestrians, motorists and nearby sensitive receivers, approval from Council would be sought and the affected community would be notified. A high-level assessment has been undertaken for out of hours works; however, a more detailed noise assessment would be undertaken if out of hours works is required.

Based on the predicted construction noise levels in Table 6.9, the criteria for the nearby receivers would be exceeded during the out of hours construction work with the potential for sleep disturbance. Noise levels are predicted to result in exceedances of both the *Road Noise Policy* ([RNP], NSW EPA, 2011) screening criteria and the awakening goals. The potential for work to generate maximum noise level events should be considered as part of the construction noise management plan for the works. Additionally, mitigation measures would be implemented for out of hours work, including a more detailed noise assessment for any out of hours work.

6.3.3.2 Construction vibration assessment

The main potential sources of vibration from the proposed construction activities are from the pile boring, jackhammering and smooth drum (vibratory) roller equipment.

The construction footprint is located approximately 35 metres from nearest residential dwellings. No activities are proposed within the cosmetic damage minimum working distances for residential receivers, therefore structural impacts are not anticipated as a result of the construction works. However, there may be instances where the vibratory roller is used within the human response minimum working distance and therefore may affect the amenity for nearby sensitive receivers (within 40 metres of the construction works). Given that there is potential for receivers to be affected by vibration intensive plant, vibration mitigation measures have been provided in Section 6.3.4 where works occur outside minimum working distances, no adverse impacts are expected for cosmetic damage or human response on nearby sensitive receivers.

6.3.3.3 Construction traffic assessment

The proposal would see construction traffic entering and exiting the site via Richmond Road, impacting on the nearest receivers on surrounding public roads. The construction workforce for the proposal would include a peak workforce of approximately 70 workers over the 12 month construction phase. On average, there would be about 15 workers in off-peak periods. Construction works would generate two to ten trucks per hour across the construction program and 30 to 50 truck movements daily during peak activities (around a six to eight week period).

The proposal would generate a minor increase in traffic noise on affected roads associated with the construction activities, however levels are expected to remain within RNP daytime criteria. During the daytime, the proposal's construction traffic is not expected to be significant when compared with the existing traffic noise.

Heavy vehicle movements during night time may exceed the relevant night time RNP criteria. Therefore, it is recommended that heavy vehicle movements should be limited to the daytime, where feasible and reasonable.

6.3.3.4 Operational noise assessment

Operational car park noise which may impact surrounding receivers typically include vehicles entering and exiting the car park, car door slams, vehicles idling in and around the car park, wheel and tyre squeals, operation of the lift and other mechanical plant and general noise from commuters.

Indicative sound power levels for the mechanical plant and equipment servicing the car park are based on sound data used on similar commuter car park projects.

The sound power levels adopted for this assessment are presented in Table 6.10.

Table 6.10 Mechanical plant sound power levels (SWL)

Source	Quantity	Sound power level dB / frequency (Hz)								
		63	125	250	500	1k	2k	4k	8k	SWL dBA
Lift motor	2	65	63	63	63	67	67	65	61	**73**
Lift shaft fan	2	70	68	68	68	72	72	70	66	**78**
Inverter	2	16	35	39	48	54	56	56	47	**61**
Generator	1	57	67	72	70	74	75	75	71	**81**

The movement of vehicles within the car park is likely to generate noise which may impact surrounding receivers. The TIA identifies that the AM and PM peak traffic volumes are to occur from 7.45 am to 8.45 am and 4.45 pm to 5.45 pm respectively. Additionally, the report predicts that the proposal would generate around 102 vehicle movements during the AM peak and PM peak.

For a worst case scenario, the AM peak vehicle movements were used in assessing the daytime period (7.00 am to 6.00 pm) and the PM peak vehicle movements were used to assess the evening periods (6.00 pm to 10.00 pm).

Additionally, the model has assumed that all vehicles enter the car park and park within five minutes.

Noise from movement of vehicles (vehicles starting, idling and driving) has been modelled using the sound power levels in Table 6.11.

Table 6.11 Car parking noise levels – onsite car movements

Source	Event sound power level dBA L_{eq}	Maximum noise level dBA L_{max}
Internal Car Movement (starting, idling and driving)[1]	74	93

(1) Measured noise levels for tor unlocking, entering and starting a light vehicle, followed by acceleration.

Based on measurements undertaken for similar projects, the noise levels from vehicle movements within car parks can be up to 4 dB louder than the Leq sound power level presented in Table 6.11. This can be attributed to wheel squeal or engine noise when travelling up ramps and would be dependent on the behaviour of the driver. To account for the potential for wheel squeal and increased engine noise when travelling up ramps, a 4 dB correction has been applied to the assumed car movement sound power level.

Prediction of operational noise impacts from the proposal has been completed using CadnaA noise modelling software (version 2021) using the ISO 9613-2 calculation method.

A three-dimensional model of the proposal was developed, including elevation contours, location of sensitive receivers, noise-generating equipment and intervening buildings. The model considered noise sources, receivers and the effect of distance, ground topography, atmospheric attenuation and obstacles such as barriers and buildings.

The proposed car park design provides aesthetic screening, however as these are not continuous, no acoustic screening would occur as a result of this design. Some vegetation would be incorporated between the proposal and the nearest residence.

Table 6.12 presents the predicted LAeq noise levels from the car park to the nearest receivers.

Table 6.12 Predicted operational noise levels

NCA	Receiver ID	NPfI noise criteria, dBA $L_{eq,15min}$			Predicted noise levels, dBA $L_{eq,15min}$		
		Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
1	R1	63[3]	–	–	43	43	38
1	R2	48	–	–	34	34	31
1	R3	50	43	38	29	29	27
1	R4	43[3]	–	–	33	33	29
1	R5	50	43	38	40	40	38
2	R6	63[3]	63[3]	63[3]	38	38	37
2	R7	49	43	38	31	31	30

(1) Time periods defined as – Day: 7.00 am to 6.00 pm; Evening: 6.00 pm to 10.00 pm; Night: 10.00 pm to 7.00 am.

(2) Receivers identified in Figure 6.5

(3) Criteria for non-residential land uses applicable when in use

Based on the assessment, the predicted noise levels comply with the day, evening and night time criteria at all receivers therefore, mitigation would not be required. Section 6.3.4 provides mitigation measures to ensure that operational noise is minimised.

6.3.4 Mitigation measures

The proposed mitigation measures are outlined in Table 6.13.

Table 6.13 Noise and vibration mitigation measures

ID	Mitigation measure	Stage
NV1	Prior to commencement of works, a Construction Noise and Vibration Management Plan (CNVMP) will be prepared as part of the CEMP and be implemented in accordance with the requirements of the ICNG. The CNVMP will take into consideration measures for reducing the source noise levels of construction equipment by construction planning and equipment selection where practicable. Reasonable and feasible noise mitigation measures which will be considered include: — avoiding/limiting simultaneous operation of noisy plant in discernible range of a sensitive receiver where practicable — switching off any equipment not in use for extended periods e.g. heavy vehicles engines would be switched off whilst being unloaded — restriction of heavy vehicle movements to and from the site to standard (daytime) hours where feasible and avoiding deliveries at night/evenings wherever practicable — no idling of delivery trucks — keeping truck drivers informed of designated routes, parking locations and acceptable delivery hours for the site — compounds, refuelling areas and work areas designed to promote one-way traffic so that vehicle reversing movements are minimised — maximising offset distances between noisy plant and adjacent sensitive receivers and determining safe working distances — using the most suitable equipment necessary for the construction works at any one time — directing noise-emitting plant away from sensitive receivers	Pre-construction/ Construction

ID	Mitigation measure	Stage
	— regularly inspecting and maintaining plant to avoid increased noise levels from rattling hatches, loose fittings etc — using non-tonal reversing/movement alarms such as broadband (non-tonal) alarms or ambient noise-sensing alarms for all plant used regularly onsite (greater than one day), and for any out of hours works.	
NV2	During SC01 (site establishment), temporary barriers will be erected to ensure that work will be conducted behind temporary hoardings/screens wherever practicable. The installation of construction hoarding will take into consideration the location of sensitive receivers to ensure that 'line of sight' is broken, where feasible. This has the potential to reduce noise levels between 5 and 10 dB.	Construction
NV3	During SC02 (demolition) to SC06 (precinct works), the concrete saw is the main contributor to construction noise. Without the concrete saw, the total activity noise level is reduced by 6–8 dB. It is recommended that the use of these plant items is limited where possible, and works are undertaken during Standard Hours. Where work is required outside of standard hours, the use of this equipment will avoid sensitive periods such as after midnight and before 7 am.	Construction
NV4	Due to the high exceedances of NMLs during SC02 (demolition) to SC06 (precinct works), when a concrete saw is to be used near sensitive receivers a temporary screen or enclosure (10–15 dB reduction) will be placed around the works in conjunction with temporary barriers.	Construction
NV5	Activities at the nearest residential receivers are likely to fluctuate over the course of the day, therefore, Council will with operators to determine feasible construction staging to manage impacts, effectively communicate likely impacts, potential periods of high intensity works, and to develop a schedule of consultation to program intensive works outside the most active periods. Respite periods will be negotiated and a community consultation strategy developed to ensure a complaints hotline and feedback pathway is established.	Construction
NV6	Works will generally be carried out during standard construction hours (i.e. 7.00 am to 6.00 pm Monday to Friday; 8.00 am to 1.00 pm Saturdays). Any works outside these hours may be undertaken if approved by Council and the community is notified prior to these works commencing. A detailed noise assessment will be prepared prior to any out of hours activities.	Construction
NV7	Where the construction noise levels are predicted to exceed 75 dBA and/or 30 dB above the Rating Background Level at nearby affected sensitive receivers, respite periods will be observed, where practicable, and in accordance with the Construction Noise and Vibration Strategy (Transport for NSW, 2019). This will include restricting the hours that very noisy activities can occur.	Construction
NV8	Where different vibration intensive equipment or different construction work areas are proposed, the vibration impacts must be reassessed.	Construction
NV9	Construction Traffic Management Plan will be developed and its findings used to inform the CNVMP. This will include delivery schedules, speed limits and circulation recommendations (measures to promote one-way traffic).	Construction

ID	Mitigation measure	Stage
NV10	Detailed design of the proposal would consider implementation of the following: — avoidance of polished concrete floors — soft closing mechanisms for stairwell doors — fully concrete or rubber speedbumps, where practicable. Mechanical plant selected must comply with the sound data provided in Table 6.10. Where additional/alternative mechanical plant and equipment is proposed, the operational noise assessment must be updated by a qualified acoustic consultant.	Detailed design

6.4 Socio-economic impacts

6.4.1 Existing environment

The proposal site is located within the suburb of Kingswood at the foot of the Blue Mountains and within the Penrith LGA. The proposal is zoned as IN1 General Industrial, SP2 Infrastructure (Railway) and R4 High Density Residential. The surrounding land uses are SP1 Special Purpose (Penrith General Cemetery) and RE1 Recreation.

St Josephs Catholic Parish primary school is located north-east, approximately 90 metres away from the site along Richmond Road. Other nearby facilities include the Nepean Hospital and medical precinct approximately 500 metres to the south-west of the site on the south side of Kingswood Station. The Western Sydney University Campus is located approximately 1 kilometre to the south-east of the site and on the southern side of the Kingswood Station.

A review of the 2016 and 2021 Australian Bureau of Statistics (ABS) data was undertaken for the suburb of Kingswood. Between 2016 and 2021, the population of Kingswood increased by 2.8% per annum from 9,301 to 10,633. Key demographics for the suburb are provided in Table 6.14.

Table 6.14 Proposal site demographics summary

Suburb	Population[1]	Median age[1]	Employment %[2]	Housing type %[1]		Transport mode (%)[2]		
				Occupied private	Unoccupied private	Car, driver or passenger	Train	Bus & train
Kingswood	10,633	34	95%	90.5	9.6	67.2	11.1	17.2

(1) 2021 ABS Census data

(2) 2016 ABS Census data.

The population of Kingswood is heavily dependent on private vehicles for the primary mode of travel to work with 67.2 per cent of the population being the driver or passenger. While car usage is considered high, use of cars for travel to work for Kingswood is similar to the NSW and Australian averages and below the Penrith City Council LGA percentage of 75.1 per cent. The use of vehicles is reflected in that 82.7 per cent of the population own at least one vehicle which is slightly lower than the NSW average and well below the Penrith LGA average of 90.4 per cent (ABS 2016).

6.4.2 Potential impacts

6.4.2.1 Construction

The proposal has potential to impact on sensitive receivers, commuters and motorists during construction due to the following:

- temporary loss of around 125 existing commuter car parking spaces (around 137 spaces would remain available in the Transport for NSW car parks throughout the construction phase)
- temporary changes to access to parking
- increased heavy vehicle movements on the surrounding road network
- construction noise and vibration, dust and visual impacts
- minor delay on the adjacent road network.

During construction, the existing car park would not be able to be used by commuters and there would be a temporary loss of around 125 car parks spaces, comprising around 114 car parking spaces in the Kingswood car park and around 11 car parking spaces in the northern Transport for NSW car park due to the construction of the shared access road. The shared access road to the Transport for NSW car park would be constructed in the early construction stages to allow access to this car park. The north and south Transport for NSW commuter car parks would retain a total of around 137 parking spaces for commuters.

It is understood a CTMP will be prepared to include parking locations for construction workers away from the station and promotion of use of public transport by workers.

6.4.2.2 Operation

The population of NSW is expected to grow by 1% per annum over the next 20 years. Growth is projected to be slightly higher at 1.13% per annum in the Penrith LGA. The population of Penrith is projected to increase by 29% between 2021 and 2041, from 216,075 to 279,477 (NSW DPE, 2021). The increased population would benefit from improved access to public transport. The proposal is expected to benefit the community by improving accessibility and providing additional parking spaces as well as providing improved access to the Kingswood Station.

The additional parking spaces would increase the number of vehicles operating in the vicinity; however, longer trips to major employment areas, such as the Sydney central business district, may be reduced through the uptake of public transport. The new parking facilities and bicycle storage would encourage more people to use public transport.

Integration of vertical plantings and landscaping as part of the proposal would seek to decrease urban heat island effects and reduce temperatures within the vicinity to provide a better commuter experience. These inclusions would also improve visual amenity for car park users and neighbours.

6.4.3 Mitigation measures

Impacts to the community would be managed through the implementation of a Community Liaison Management Plan (CLMP) before, during and after construction. Communities would continue to be engaged with throughout the proposal to be kept up to date, and a 24-hour contact would be available to discuss any questions or concerns. Where practicable, feedback and input of stakeholders would be implemented into the proposal.

Refer to Chapter 7 for a detailed list of safeguards and mitigation measures. The proposed mitigation measures are outlined in Table 6.15.

Table 6.15 Socio-economic mitigation measures

ID	Mitigation measure	Stage
SE1	Impacts to the community would be managed through the implementation of a Community Liaison Management Plan (CLMP) prepared prior to construction.	Pre-construction/ Construction/ Operation
SE2	Contact details for a 24-hour construction response line, Project Infoline and email address will be provided for ongoing stakeholder contact throughout the construction phase.	Pre-construction/ Construction/ Operation

6.5 Biodiversity

An Arboricultural Assessment was prepared by Arterra Design (see Appendix H). A desk-top assessment of biodiversity was also undertaken by WSP (see Appendix K). The results of the assessment are summarised in this section.

6.5.1 Existing environment

The proposal site consists of a small area with mature trees between the southern boundary of the Council at-grade commuter car park and the Kingswood Station (see Figure 6.6). The trees are growing close to the Council car park boundary and their canopies overhang the first row of parking. There are a further eight trees growing in a garden bed hard against the station building (see Figure 6.7).

Figure 6.6 Photo of the trees within the proposal site directly south of the Council at-grade commuter car park

Figure 6.7 Photo of the trees located along Kingswood Station

Historical aerial images indicate that the trees were planted in the 1980s as there were no trees planted on the site in 1978. There are currently 34 trees recorded and assessed within the proposal site. Due to their age class distribution and location, most of the trees appear to have been planted on the site, while the much smaller and younger specimens are likely to be self-sown. The trees are a mix of native and non-native species.

Table 6.16 provides a summary of the trees found on the proposal site and some factors regarding development of the site.

Table 6.16 Summary of trees recorded on proposal site

Common name	Species	Native	Quantity
Spotted Gum	*Corymbia maculata*	Yes	9
River She-Oak	*Casuarina cunninghamiana*	Yes	4
Brushbox	*Lophostemon confertus*	Yes	3
Broad Leafed Paperbark	*Melaleuca quinquenervia*	Yes	3
Variegated Weeping Fig	*Ficus benjamina 'Variegata'*	No	2
Swamp She-Oak	*Casuarina glauca*	Yes	2
Mugga Ironbark	*Eucalyptus sideroxylon*	Yes	1
Camden White Gum	*Eucalyptus benthamii*	No	1
Willow Bottlebrush	*Callistemon salignus cv.*	No	1
Crimson Bottlebrush	*Callistemon citrinus cv.*	No	1
Woollybutt	*Eucalyptus longifolia*	No	1
Weeping Bottlebrush	*Callistemon viminalis cv.*	No	3
Flax Leaved Paperbark	*Melaleuca linariifolia*	No	1

Common name	Species	Native	Quantity
Prickly Paperbark	*Melaleuca styphelioides*	No	1
Water Gum	*Tristaniopsis laurina*	No	1
Total Population			**34**

A search of the EPBC Act Protected Matters Search Tool was undertaken on 8 July 2022 (see Appendix K) for a 500 metre buffer of the proposal site. The following within the search area:

- 7 threatened ecological communities
- 43 threatened species
- 13 migratory species.

The search of the NSW BioNet Species Sightings Data Collection on 19 May 2022 found no records of threatened species within the proposal site (DPE, 2022b). The potential for threatened species or communities to occur in the proposal site is unlikely, due to the lack of suitable habitat and disturbed nature of the site. The habitat connectivity is considered to be low given the typically low level of vegetation across the site and in neighbouring properties. The proposal site is unlikely to provide habitat for native fauna species.

6.5.2 Potential impacts

6.5.2.1 Construction

The proposal requires the removal of around 27 trees during construction (subject to refinement of the design) due to their location within the area directly impacted by the proposed works. Seven trees are proposed to be retained (refer to Figure 6.8). These trees (T26-T32) are relatively small Australian native trees growing in a narrow garden bed on the southern boundary of the proposal site. One tree (T30) is a slightly larger *Melaleuca styphelioides* (Prickly Paperbark) and one tree (T32) is a small *Melaleuca quinquenervia* (Broad-leaf Paperbark) with nominal Tree Protection Zones (TPZs) that extend beyond the northern edge of the existing concrete pathway.

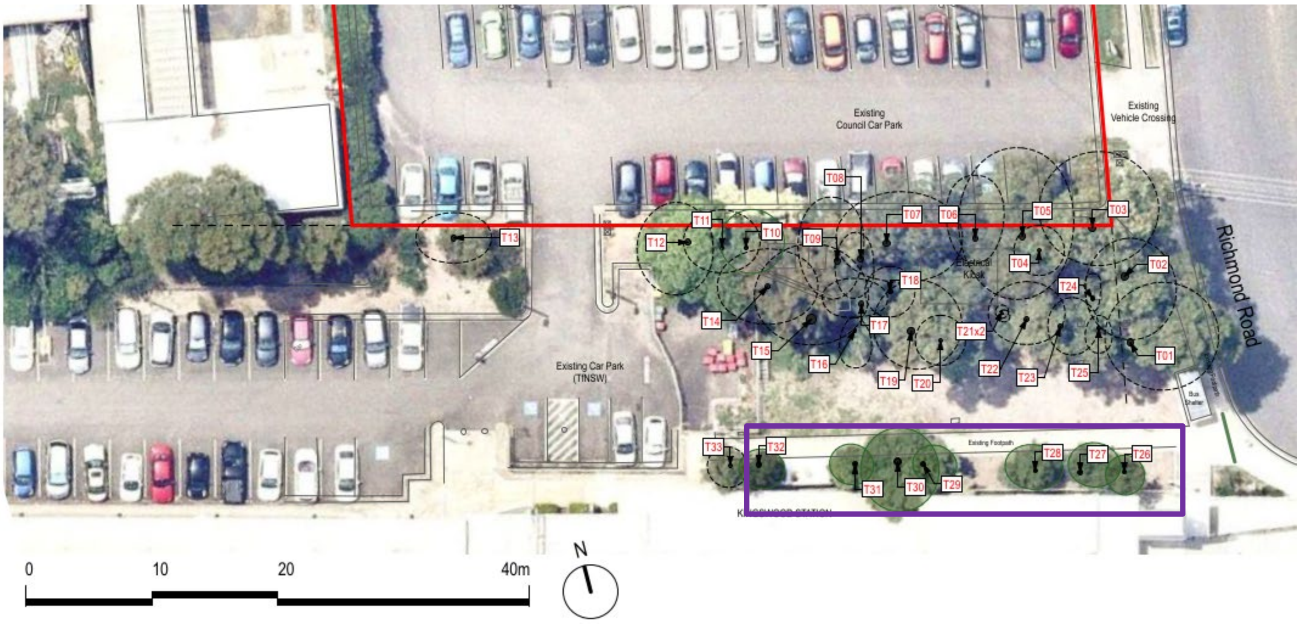

Figure 6.8 Trees recorded within the proposal site. Note: Trees to be retained are identified within the purple box

Potential impacts to remaining trees during construction are tree damage and reduced life expectancy, caused by:

- root loss and disturbance due to inappropriate excavation for the building, pathways and services
- compaction of the root zone from storage or stockpiling of materials
- contamination of the soil from the preparation of chemicals, wash down/cleaning of equipment
- refuelling of vehicles and dumping of waste
- compaction of the root zones from use of vehicles/plant equipment
- root disturbances from unauthorised cut and fill and soil level changes
- physical damage to the tree trunks and branches from passing machinery
- damage to the tree roots from landscaping, services installation and pedestrian pathway construction.

Biodiversity impacts from the proposal are predicted to be minimal due to the disturbed nature of the proposal site. No impacts to threatened native vegetation or high-quality fauna habitat are expected to occur.

As part of the Council's *Cooling the City Strategy* (Penrith City Council, 2015), the proposal would seek to ensure the trees proposed to be removed would be offset. Landscaping work is proposed to the south of the proposed multi-storey commuter car park and new street trees are proposed adjacent to the multi-storey car park on Cox Avenue and Richmond Road. Vertical plantings are proposed on the facade of the proposed multi-storey car park.

6.5.2.2 Operation

The proposal is unlikely to impact biodiversity during operation. The street trees on Cox Avenue and Richmond Avenue and trees and plantings between the proposed car park and Kingswood Station would be maintained during operation of the proposal.

6.5.3 Mitigation measures

The proposed mitigation measures are outlined in Table 6.17.

Table 6.17 Biodiversity mitigation measures

ID	Mitigation measure	Stage
B1	Disturbance of vegetation will be limited to the minimum amount necessary to construct the proposal. Trees nominated for removal will be clearly demarcated onsite prior to construction. Tree protection will be undertaken in line with AS 4970-2009 Protection of Trees on Development Sites. Trees to be retained will be protected through temporary tree protection fencing and trunk protection battens. Access will be controlled so that movement does not occur through any tree protection areas.	Pre-construction/ Construction
B2	All workers will be provided with an environmental induction prior to commencing work onsite. This induction will include information on the protection measures to be implemented to protect trees.	Construction
B3	Access will be controlled so that movement does not occur through any tree protection areas.	Construction
B4	The demolition of the existing concrete footpath adjacent to the trees to be retained will be overseen by a qualified arborist to ensure roots growing below or adjacent to the path are adequately protected.	Construction
B5	The storage or stockpiling of any materials will avoid the tree protection areas.	Construction

6.6 Aboriginal heritage

An Aboriginal Due Diligence and Historic Heritage Desktop Assessment Report was prepared by Ozark (refer Appendix I). The results of the Aboriginal Due Diligence Assessment are summarised in this section.

6.6.1 Existing environment

A search of the Aboriginal Heritage Information Management Search (AHIMS) database was conducted on 3 June 2021 and an area within a 10 km buffer around the proposal site was searched to understand the archaeological context of the area and any previously recorded Aboriginal sites or places. The AHIMS search returned 106 records for Aboriginal sites within 10 kilometres around the proposal site. A second search of the AHIMS database was conducted on 11 July 2022 by WSP (included in Appendix I) with a 1 kilometre buffer around the proposal site as search and found zero Aboriginal sites or places.

The site is not located on a landscape feature that is likely to indicate the presence of Aboriginal objects in accordance with the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (Office of Environment and Heritage, 2010).

The proposal site has been disturbed for the purpose of constructing car parking and road infrastructure. There is a low risk of Aboriginal objects being present within the proposal site due to the history of disturbance and as no known objects were identified within the proposal site. Therefore, it is considered unlikely that any Aboriginal heritage items would be harmed during construction and operation of the proposal.

6.6.2 Potential impacts

6.6.2.1 Construction

Construction of the proposal would involve earthworks and other ground disturbance activities which have the potential to impact Aboriginal sites, if present. As no known Aboriginal sites or areas are located in the vicinity of the proposal site and the potential for unknown items is considered to be low, the proposal is unlikely to affect Aboriginal heritage during construction.

The due diligence process resulted in the outcome that an Aboriginal Heritage Impact Permit (AHIP) is not required as demonstrated in Table 6.18.

Table 6.18 Due diligence code application

Item	Reasoning	Answer
Will the activity disturb either of the following: — the ground surface where archaeological deposits are likely — mature, native trees that may be culturally modified.	The proposal would disturb the ground surface through excavation and construction. The ground surface is assessed as having clear and observable evidence of previous European disturbance from as early as 1943. The proposal would not impact mature, native vegetation, as these have been removed from the study area between 1947 and 1965.	No
Are there any relevant records of Aboriginal heritage on site (AHIMS or from other sources), or landscape features that are likely to indicate presence of Aboriginal objects?	AHIMS indicated no Aboriginal sites within the study area, with the closest site located 1.5 kilometres to the east. No landscape features in the study area indicate the likely presence of Aboriginal objects. No outcropping stone or ideal landforms for Aboriginal occupation are evident from historical aerial imagery from 1943 to 2006.	No

Item	Reasoning	Answer
Will the activity impact Aboriginal objects or landforms with archaeological potential?	There are no known items of Aboriginal significance present in the study area, and landforms with identified archaeological sensitivity are not present.	No
Does the desktop assessment confirm that Aboriginal objects will be harmed?	Desktop searches found no known items of Aboriginal heritage in the study area. It is assessed that there is a low likelihood of there being subsurface archaeological deposits within the study area due to previous disturbances seen through the historical aerial imagery of the area.	No
AHIP not necessary. Proceed with caution.		

6.6.2.2 Operation

The proposal would not result in impacts to Aboriginal heritage during operation.

6.6.3 Mitigation measures

The proposed mitigation measures are outlined in Table 6.19.

Table 6.19 Aboriginal heritage mitigation measures

ID	Mitigation measure	Stage
AH1	The proposed works will proceed at the Kingswood commuted car park without further archaeological investigation under the following conditions: — All land and ground disturbance activities will be confined to within the study area, as this will eliminate the risk of harm to Aboriginal objects in adjacent landforms. Should the parameters of the project extend beyond the assessed areas, then further archaeological assessment will be required. — All staff and contractors involved in the proposed work will be made aware of the legislative protection requirements for all Aboriginal sites and objects.	Pre-construction/ Construction
AH2	An Unanticipated Finds Protocol will be developed and included in the CEMP to provide a consistent method for managing any unexpected Aboriginal heritage items discovered during construction, including potential heritage items or objects, and human skeletal remains.	Pre-construction/ Construction
AH3	This assessment has concluded that there is a low likelihood that the proposed work will adversely harm Aboriginal cultural heritage items or sites. If during works, however, Aboriginal artefacts or skeletal material are noted, all work will cease and the procedures in the Unanticipated Finds Protocol will be followed.	Construction
AH4	Inductions for construction workers will include a cultural heritage awareness procedure to assist with recognising Aboriginal artefacts and construction workers are aware of the legislative protection of Aboriginal objects under the *National Parks and Wildlife Act 1974* and the contents of the Unanticipated Finds Protocol.	Construction
AH5	The information presented here meets the requirements of the Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales. It will be retained as shelf documentation for five years as it may be used to support a defence against prosecution in the event of unanticipated harm to Aboriginal objects.	Construction / Operation

6.7 Non-Aboriginal heritage

An Aboriginal Due Diligence and Historic Heritage Desktop Assessment Report was prepared by Ozark (refer Appendix I). The results of the assessment are summarised in this section.

6.7.1 Existing environment

A desktop search was undertaken to identify non-Aboriginal heritage (historic) items within or in the vicinity of the proposal site. The following databases were searched:

- National and Commonwealth Heritage Listings
- State Heritage Listings
- Penrith LEP.

No heritage items were identified within the proposal site. The nearest heritage item to the proposal site is the locally listed Penrith General Cemetery (Penrith LEP I97) located approximately 20 metres north of the proposal site, across Cox Avenue as shown on Figure 6.9.

An aerial assessment of historical aerial imagery found that there have been no previous structures or clearly defined sensitive landforms within the proposal site, and hence the presence of sub-surface archaeological deposits within the site are unlikely.

6.7.2 Potential impacts

6.7.2.1 Construction

There are no heritage listed items within the proposal site and presence of subsurface deposits are unlikely. As such, the proposal is unlikely to result in a direct impact to any known heritage values or sub surface archaeological deposits during construction.

Impacts to the Penrith General Cemetery would be unlikely as construction of the proposal would not impact this area.

6.7.2.2 Operation

Operation of the proposal is unlikely to have direct impacts on non-Aboriginal heritage.

6.7.3 Mitigation measures

Potential impacts to non-Aboriginal heritage would be managed through the implementation of the CEMP prepared by the contractor that would map and protect nearby non-Aboriginal heritage items and prescribe management measures to ensure these items are not affected.

The proposed mitigation measures are outlined in Table 6.20.

Table 6.20 Non-Aboriginal heritage mitigation measures

ID	Mitigation measure	Stage
H1	An Unanticipated Finds Protocol will be developed and included in the CEMP to provide a consistent method for managing any unexpected non-Aboriginal heritage items discovered during construction.	Pre-construction/ Construction
H2	Any unexpected archaeological deposits will be managed in accordance with relevant legislation and stop-work procedures to be prepared by the contractor and included in the CEMP.	Pre-construction/ Construction

wsp

Kingswood Commuter Car Park

Figure 6.9
Nearby listed heritage items in relation to the study area

Legend

- Cadastre
- Proposal Site
- Council at-grade car park
- Transport for NSW car park
- LEP Listing Curtilage

0 100 200 Meters

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

1:5,000 Date: 13/07/2022

Data sources: - DNRME, TMR, Translink, Geoscience Australia

6.8 Soil and contamination

6.8.1 Existing environment

The site currently consists of a single-level car park, primarily used for commuters at Kingswood Station.

A review of site history information suggests that the site was predominantly vacant/rural land from at least 1943 until the 1960s, when works were undertaken to develop the present-day commuter car park, associated with Kingswood Station. Based on historical land titles, it is likely the site may have been used to store building materials between 1921 and 1961, which potentially included asbestos. Land surrounding the site appeared to have originally been used for agricultural purposes, with residential, commercial and industrial properties being developed within close proximity (Douglas Partners, 2021b).

6.8.1.1 Topography

Topography on site is between approximately 49.6 and 52.5 metres AHD (mAHD). The topography gently trends downgradient towards the south-east at gradients estimated to be up to 4 degrees. The Kingswood area generally comprises undulating hills with elevations typically between 50 and 60 mAHD (Douglas Partners, 2021b).

6.8.1.2 Geology and soils

Reference to the Penrith 1:100,000 scale Geological Series Sheet indicates that the proposal site is located within the Luddenham soil landscape group and is underlain by Bringelly Shale of Triassic Age. Bringelly Shale typically comprises interlayered siltstone/claystone with some fine to medium grained sandstone layers, which weather to a residual clay profile of medium to high plasticity (Douglas Partners, 2021b).

6.8.1.3 Acid sulfate soils and salinity

A review on the NSW ePlanning website on 22 April 2022 indicated there are no acid sulfate soils within the proposal site or the surrounding area (DPE, 2022a).

The geotechnical investigation (Douglas Partners, 2021a) for the site suggests that the site is in an area of 'moderate salinity potential' with a higher potential in the lower elevation areas in close proximity to the Werrington Creek system. A search on the NSW ePlanning website on 22 April 2022 did not reveal any salinity on or within close proximity to the proposal site (DPE, 2022a).

6.8.1.4 Contamination

WSP undertook a review of Douglas Partners Preliminary Site Investigation (PSI) report, prepared for part (Lot 1 DP 198211) of the proposal site (refer Appendix J). The findings of this review are summarised in this section.

A search of the NSW EPA contaminated land database indicated that the site, and surrounding properties within 500 metres are not currently registered on the NSW EPA list of contaminated sites, nor were they are currently regulated by the EPA as a contaminated site. A search of the public register for public registers, licenses, applications and notices, maintained by the NSW EPA in relation to records pertaining to the site was also undertaken. The search indicated that there are currently no active or former licenses pertaining to the site.

The intrusive soil investigation identified the presence of fill material on site, with depths ranging from 0.06 to 0.8 (metres below ground level) (mBGL). Although asbestos was not encountered within any boreholes during the investigation, due to the presence of fill soil on site, there is potential for occurrence of asbestos and/or other contaminants of potential concern (COPC's).

The PSI recommended that a vapour assessment be undertaken along the western boundary to investigate the potential for impacts to groundwater from the adjacent cleaning products site (refer below). Additionally, due to the importation of fill across the site from an unknown source, and given that the fill was placed during times when asbestos use was prevalent, there is the potential that asbestos is present in the fill in areas not investigated. It is recommended that an Unexpected Finds Protocol be prepared and included in the CEMP to assess and manage unexpected finds of contamination during development.

Based on the PSI, it was concluded that the site could be made suitable for the proposed development, subject to further investigations on site, which targeted potential impacts to groundwater from the industrial facility immediately to the west of the site.

Douglas Partners were engaged by Penrith City Council (c/o Root Partnerships) in June 2021 to complete a preliminary soil gas assessment at the site (refer Appendix J). Douglas Partners concluded that based on the results of the passive soil assessment, concentrations of volatile organic carbons (VOCs) on site were not considered to pose an unacceptable risk and the site was suitable for the proposed car park development. It was further noted that an Unexpected Finds Protocol (as recommended in the DP PSI (2021b)) should be prepared and implemented to manage any unexpected finds during the redevelopment.

Douglas Partners were again engaged by Penrith City Council in June 2021 to complete a preliminary In-Situ Waste Classification assessment at the site (refer Appendix J). The waste classification was to provide a preliminary waste classification assessment based on analytical results reported in the PSI (above). Based on the soil analytical results, fill materials on site were preliminarily classified as General Solid Waste (GSW) – non-putrescible. It was considered that a majority of natural soils were preliminarily classified as virgin excavated natural material (VENM), with localised areas of natural material identified to contain benzo(a)pyrene and total recoverable hydrocarbons classified as GSW – Non-putrescible. In order to provide VENM certification, appropriate segregation and validation of overlying fill and exceedances recorded in natural soil would need to be completed by an environmental consultant.

6.8.2 Potential impacts

6.8.2.1 Construction

Following removal of existing bitumen and subgrade, excavation works would be required to allow for the lower ground floor, footings and pits for lift shafts. General trenching, excavation and/or grading would also be required for installing services, drainage works, new paving, and tree removal.

The PSI (refer Appendix J) noted that due to the identification of imported fill across the site from an unknown source, there is potential that asbestos is present in the fill in areas not investigated. The presence/absence of asbestos would unlikely be confirmed until the hardstand across the site is removed and underlying fill is exposed and excavated during construction. It is possible that localised areas of underlying natural material had been impacted by overlying fill or other non-site sources.

The PSI found potential sources of contamination and associated COPC's were identified including metals/metalloids, total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene, xylene (BTEX), polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), organochlorine pesticides (OCP), organophosphorus pesticides (OPP), phenols, asbestos and VOCs. There is potential risk during construction that if found and not managed correctly could present a risk to the health of construction workers and community.

6.8.2.2 Operation

There would be minimal to no impacts to contamination, landform, geology and soils during operation of the proposal.

An increased number of cars would be using the site during operation potentially increasing the potential for stormwater to collect contaminants from heavy vehicles or fuel left by vehicles using the car park.

6.8.3 Mitigation measures

The proposed mitigation measures are outlined in Table 6.21.

Table 6.21 Soil and contamination mitigation measures

ID	Mitigation measure	Stage
S1	An Unexpected Finds Protocol will be prepared and implemented as part of the CEMP to assess and manage unexpected finds of contamination during development.	Pre-construction/ Construction
S2	A Licensed Asbestos Assessor will be engaged to assess exposed fill soil surfaces on site, following removal of the existing bitumen and subgrade, prior to excavation of any fill material. The Licensed Asbestos Assessor will inspect the soil surfaces in order to identify any potential ACM and provide further direction (i.e. approval to excavate or recommendations in the event that ACM is encountered).	Construction
S3	Testing will be conducted by an environmental consultant, prior to any waste being taken off-site to a licenced disposal facility.	Construction
S4	An Erosion and Sediment Control Plan (ESCP) will be implemented during construction of the proposal to mitigate impacts to soils and erosion during excavation and earthworks.	Construction
S5	Fuels, oils and other chemicals will be stored at an appropriate bunded location and away from waterways or stormwater drains.	Construction
S6	Refuelling of construction machinery and vehicles will take place at an appropriate location away from waterways or stormwater drains.	Construction

6.9 Hydrology and water quality

6.9.1 Existing environment

6.9.1.1 Surface water

The proposal site is located within the Werrington Creek sub-catchment of the South Creek Catchment. The closest watercourse is a tributary of Werrington Creek located approximately 300 metres south-east.

The topography of the site is relatively flat. Surface water in the vicinity of the site is managed by the Council's stormwater drainage system consisting mainly of kerb and gutter drainage connected to an underground pipe network. The drainage in the immediate area comprises the stormwater drains and pipes within the road network and at-grade car parks.

6.9.1.2 Groundwater

A search of the NSW Department of Primary Industries Water (DPI Water) online map of registered groundwater works was undertaken as part of the investigation. The search carried out on 22 April 2022 identified no registered groundwater boreholes within 500 metres of the site.

A geotechnical investigation undertaken by Douglas Partners Pty Ltd in April 2021 involved drilling boreholes to depths of up to 7.8 metres within the site. Groundwater was not encountered during this investigation (Douglas Partners, 2021a).

No free groundwater was observed during augering and the use of water as a drilling fluid prevented groundwater observations during rotary drilling and coring. Backfilling of the boreholes at the completion of drilling precluded long-term monitoring of the groundwater levels. It is noted, however, that groundwater levels are affected by preceding climatic conditions and soil/rock permeability and can therefore fluctuate with time.

6.9.1.3 Flooding

A search on the NSW ePlanning database on 22 April 2022 found the site is not mapped as flood prone or as groundwater vulnerability area. A search of the NSW State Emergency Service (SES) flood map on 19 May 2022 found the site is not mapped within the Hawkesbury-Nepean Valley floodplain (SES, 2022).

6.9.2 Potential impacts

6.9.2.1 Construction

Construction excavation and stockpiling may disturb soils, cause erosion of exposed soils and cause sedimentation within drainage systems and receiver watercourses. Earthworks and removal of vegetation would temporarily expose the natural ground surface to runoff and wind that would increase soil erosion potential. Activities that disturb soil during construction have the potential to impact upon local water quality as a result of erosion and run off sedimentation.

The potential for erosion impacts would be minimised by implementing standard best-practice management measures including erosion controls.

Impacts to groundwater are considered to be unlikely as majority of the works would not require excavation to a depth that would intercept groundwater. Works such as excavation for the lift shafts would require deeper excavations; however, during geotechnical investigations undertaken by Douglas Partners Pty Ltd in April 2021 groundwater was not encountered during drilling of boreholes up to 7.8 metres in depth, and hence these activities are unlikely to impact on groundwater. Extraction from groundwater bores and surface water is not anticipated to be required for the proposal. If groundwater is encountered during construction, appropriate measures should be implemented in accordance with the relevant guidelines and legislation.

Small volumes of water would be required during construction for dust suppression, potable water for workers and other construction tasks such as cleaning.

6.9.2.2 Operation

There would be minimal to no hydrology and water quality impacts during operation of the proposal. The proposal would be constructed within the footprint of the existing car park and would not result in net increase of impermeable surfaces. Therefore, there would be no significant increase in stormwater run-off.

Rainwater collection would be incorporated into the proposal, subject to ongoing refinement of the design.

Stormwater and drainage works would be designed and undertaken in accordance with the relevant Australian and Authority Standards, including Sydney Trains and Penrith City Council standards and requirements.

6.9.3 Mitigation measures

The proposed mitigation measures are outlined in Table 6.22.

Table 6.22 Hydrology and water quality mitigation measures

ID	Mitigation measure	Stage
SW1	An Erosion and Sediment Control Plan will be prepared and implemented for the proposal to manage risks to water quality. The plan will be prepared in accordance with best onsite practice, reflected in Managing Urban Stormwater–Soils and Construction, Volume 1 (Landcom, 2004) and Volumes 2A and 2C (DECC, 2008) also known as 'The Blue Book'.	Pre-construction/ Construction
SW2	All material will be swept, removed and deposited onto the access roads at the end of each working shift and before rainfall.	Construction

ID	Mitigation measure	Stage
SW3	Construction workers will routinely check and record that all erosion and sediment controls are maintained and effective and undertake additional inspections following a rainfall event of 10 millimetres or greater.	Construction
SW4	Emergency spill kits will be kept onsite with all staff aware of their location and trained in their use.	Construction
SW5	Should groundwater be encountered during excavation works, groundwater will be managed in accordance with the requirements of the *Waste Classification Guidelines* (EPA, 2014) and Transport for NSW's *Water Discharge and Reuse Guideline* (TfNSW, 2019).	Construction

6.10 Air quality

6.10.1 Existing environment

The existing air quality is considered to be representative of an urban environment. Potential sources of emissions would include the adjacent industrial area, vehicle emissions and the railway corridor.

A search of the daily regional air quality index for the Sydney North West region for this year showed that the region experienced predominantly 'good' air quality (DPE, 2022c).

A search of the National Pollutant Inventory database 2020/21 data within Kingswood indicates that there are no nearby facilities that are monitored for air quality. The nearest facility to Kingswood Station that has pollution is over three kilometres away and is a Milk and Cream Processing facility. Other key sources of localised air pollution in the vicinity of the proposal are vehicle exhaust fumes and diesel locomotives.

Sensitive receivers in close proximity of the proposal site include:

- residents on Richmond Road and Park Avenue
- workers in adjacent commercial and industrial area
- pedestrians and commuters within the local area
- staff at Kingswood Station.

6.10.1.1 Construction

The main air quality impacts that have potential to occur during construction would be temporary impacts associated with dust particles and greenhouse gas emissions such as Carbon Dioxide (CO_2), nitrous oxides and polycyclic aromatic hydrocarbons (PAH) compounds associated with the combustion of diesel fuel and petrol from construction and plant equipment (DPE, 2022c).

The proposal would have potential impact on air quality as it would involve some excavation and/or land disturbance with the potential to generate dust. However, this is unlikely to be significant and would be short-term.

The operation of plant, machinery and trucks may also lead to increases in exhaust emissions in the local area; however; these are expected to be minor and short-term.

6.10.1.2 Operation

The increased capacity of the commuter car park would increase the number of vehicles in the area, and local vehicle emissions are likely to increase. It is predicted that during operation, the proposal would generate around 102 vehicle movements during the morning and afternoon peak hours. However, this increase is unlikely to be noticeable and is not expected to have major impacts on local air quality.

Mechanical ventilation would be installed in the proposed multi-storey car park to ensure the air quality in the structure meets the requirements for an open multi-storey car park. The mesh façade would also provide open ventilation within the car park that provide natural air flow.

Increased patronage of the rail system would likely result in a relative reduction of commuter vehicle movements on roads, with a corresponding relative reduction in vehicle emissions in the long term, which would have beneficial effects on local and regional air quality.

6.10.2 Mitigation measures

Measures such as maintaining and operating plant and equipment efficiently and implementing measures for dust suppression including watering, covered loads and appropriate management of tracked dirt/mud on vehicles would mitigate impact on local air quality. Mitigation measures relating to air quality would be included in the CEMP to be prepared for the proposal.

The proposed mitigation measures are outlined in Table 6.23.

Table 6.23 Air quality mitigation measures

ID	Mitigation measure	Stage
AQ1	Methods for management of emissions will be incorporated into project inductions, training and pre-start/toolbox talks.	Construction
AQ2	Plant and machinery will be regularly checked and maintained in a proper and efficient condition. Plant and machinery will be switched off when not in use, and not left idling.	Construction
AQ3	Vehicle and machinery movements during construction will be restricted to designated areas and sealed/compacted surfaces where practicable.	Construction
AQ4	To minimise the generation of dust from construction activities, the following measures will be implemented: — apply water (or alternate measures) to exposed surfaces (e.g. unpaved roads, stockpiles, hardstand areas and other exposed surfaces) — cover stockpiles when not in use — appropriately cover loads on trucks transporting material to and from the construction site and securely fix tailgates of road transport trucks prior to loading and immediately after unloading — prevent mud and dirt being tracked onto sealed road surfaces.	Construction

6.11 Waste

6.11.1 Existing environment

Minimal waste is generated on the proposal site as it is currently an at-grade car park. The wasted generated primarily includes personal waste from commuters using the car park.

6.11.2 Potential impacts

6.11.2.1 Construction

Approximately 3,670 cubic metres of spoil would be excavated and removed as part of the proposal. Spoil has the potential to affect the local environment if it is not managed appropriately.

During construction of the proposal, the following waste materials would be generated:

- surplus building materials
- asphalt and concrete
- spoil from earthworks
- green waste
- various building material wastes
- general waste, including food and other wastes generated by construction workers.

Waste impacts are unlikely to occur if standard construction site management measures are implemented to prevent pollution. Waste management measures would be outlined in the CEMP.

6.11.2.2 Operation

Operation of the proposal is not expected to result in changes to operational waste. Minimal waste is expected to be generated from use of the proposal.

6.11.3 Mitigation measures

Waste management would be undertaken in accordance with the *Waste Avoidance and Recovery Act 2001*. A Waste Management Plan would be prepared and implemented to identify all potential waste streams associated with the work and outline methods of disposal of waste that cannot be reused or recycled at appropriately licenced facilities along with additional onsite management practices such as keeping the area tidy and free of rubbish.

The proposed mitigation measures are outlined in Table 6.24.

Table 6.24 Waste mitigation measures

ID	Mitigation measure	Stage
W1	A Waste Management Plan will be prepared and implemented as part of the construction environmental management plan. The WMP will outline: — method of containment and/or treatment of contaminated soil — adequate safe removal techniques — management measures to prevent the spread of contamination — location of acceptable waste facility — measures of transport of material to ensure loads are covered and waste is not dispersed during transport.	Pre-construction/ Construction
W2	All materials excavated (soils and sediments) will be tested in accordance with the *NSW EPA Waste Classification Guidelines Part 1: Classifying Waste* (2014a).	Construction

ID	Mitigation measure	Stage
W3	The contractor will be appropriately licensed to remove and dispose of any potential hazardous materials in accordance with relevant guidelines and regulations. Potential hazardous materials will be handled and disposed in accordance with relevant Australian Standards, WorkCover and regulatory agency (EPA) guidelines.	Construction
W4	All waste fluids generated during the works, including from the washing of painting equipment, will be contained for proper disposal offsite. Cleaners, solvents, paints or other inorganic liquids will not be disposed on site.	Construction
W5	All waste removal, transport and disposal, including excess spoil, will be in accordance with the EPA's current guidelines for waste. Materials will be recycled wherever possible. Dockets or equivalent evidence will be obtained for all recycling and waste disposal, detailing the weights, materials, time and date and waste facility used.	Construction
W6	An Operational Waste Management Plan will be prepared to manage waste for the proposal.	Operation

6.12 Climate change and greenhouse gas emissions

6.12.1 Existing environment

The existing air quality is considered to be representative of an urban environment. Potential sources of emissions would include the adjacent industrial area (to the west of the proposal site), vehicle emissions and the railway corridor.

Climate change is affecting the urban environment and will lead to weather changes, storm intensity, flooding, heat and increased risk of fire. Based on long-term (1910–2013) observations, temperatures in the Metropolitan Sydney region have been increasing since about 1960, with higher temperatures experienced in recent decades (DPE, 2022e). Areas inland such as Penrith are expected to have an increase in high temperature days and fewer cold nights in the future (2020–2039) and far future (2060–2079) (DPE, 2022e).

Rainfall is projected to increase, and the region is expected to experience an increase in severe fire weather in summer and spring (DPE, 2022e). Climate change is expected to add to the risks and vulnerability in urban areas (Intergovernmental Panel on Climate Change, 2014).

The detailed design would consider the impacts of climate change on the proposal through:

- vertical plantings including automatic watering system
- rainwater tanks for landscape irrigation and toilet flush
- roof shading 99 kilowatt solar panels to the rooftop
- energy efficient LED lighting
- EV charging
- possible adoption of modular design and construction methods such as 'green concrete' that provides carbon savings.

6.12.1.1 Bushfire risk

A search undertaken on 18 May 2022 on the NSW ePlanning portal found the site is not located on or within close proximity to bushfire prone land. Climate change could lead to an increase in frequency and intensity of bushfires; however, as the proposal site is not located on bushfire prone land impacts would be negligible.

6.12.1.2 Urban heat

Climate change is increasing average temperatures across NSW including an increase in annual average temperatures and the number and duration of extreme hot weather events. In cities, particularly Western Sydney, average temperatures can be up to 10°C higher than rural temperatures and can trap more heat than natural environments (DPE, 2022f).

Urban heat islands happen when an area has hard, sealed surfaces and less green infrastructure (such as tree canopy, vegetation and waterways). Hard surfaces absorb, store and radiate heat while green infrastructure reflects heat and provides shade (DPE, 2022f).

Urban heat and the 'urban heat island effect' (when urban environments trap more heat than natural environments) are increasing the heat-related impacts of climate change in urban areas, making increased temperatures and extreme hot weather events more severe (DPE 2022f).

6.12.2 Potential impacts

6.12.2.1 Construction

An increase in greenhouse gas emissions, primarily carbon dioxide, would be expected during construction of the proposal due to exhaust emissions from construction machinery and vehicles transporting materials and personnel to and from the site.

However, due to the small scale of the proposal and the short-term temporary nature of the individual construction works, it is considered that greenhouse gas emissions resulting from construction of the proposal would be minimal.

6.12.2.2 Operation

The effects of urban heat would impact the proposal once operational. The proposal has been designed to add greenery and vegetation in the form of landscaping and vertical plantings to the facade which aim to reduce the impacts of urban heat.

Once operational the proposal would result in an increase in use of public transport and a decrease in use of private motor vehicles by commuters to travel to and from Kingswood Station. This shift in transport would reduce the amount of fuel consumed by private motor vehicles with a corresponding relative reduction in associated greenhouse gas emissions. A modal shift in transport usage may reduce the amount of fuel consumed by private motor vehicles with a corresponding relative reduction in associated greenhouse gas emissions in the local area.

Additional renewable energy options such as the inclusion of solar panels on the rooftop, energy efficient lighting, rainwater tanks and the provision for electric vehicle charging stations would be incorporated into the proposal. By implementing renewable energy options, the operational car park would be less reliant on electricity from the grid.

6.12.3 Mitigation measures

The proposed mitigation measures are outlined in Table 6.25.

Table 6.25 Climate change mitigation measures

ID	Mitigation measure	Stage
CC1	Detailed design of the proposal will be undertaken in accordance with the *NSW Sustainable Design Guidelines – Version 4.0* (Transport for NSW, 2019a). The proposal will include sustainability measures such as: — vertical plantings including automatic watering system — rainwater tanks for landscape irrigation and toilet flush — roof shading 99 kilowatt solar panels to the rooftop — energy efficient LED lighting — electric vehicle charging — possible adoption of modular design and construction methods such as 'green concrete' that provides carbon savings.	Pre-construction
CC2	Materials will be selected materials for durability in extreme conditions that minimise heat retention.	Pre-construction
CC3	Engineering and design features will ensure structures are constructed to minimise direct impacts from severe storms and strong winds.	Pre-construction

6.13 Cumulative impacts

6.13.1 Existing environment

Cumulative impacts occur when two or more projects are carried out concurrently and in close proximity to one another. The impacts may be caused by both construction and operational activities and can result in greater impact to the surrounding area than would be expected if the projects were undertaken in isolation. Multiple projects undertaken at a similar time or location may lead to construction fatigue, particularly around noise, traffic and air quality impacts if not appropriately managed.

A search on the DPE Major Projects Register on 22 April 2022 identified one development within 1 kilometre of the proposal site. The relevant project has been listed in Table 6.26.

Table 6.26 Projects within vicinity of the proposal

Name of project	Description	Address	Distance from proposal	Status
Nepean Hospital Redevelopment Project – Stage 2	Demolition of existing structures, construction of a part 7 and 11 storey tower connecting into the Stage 1 tower, reconfiguration of public and service access and ancillary landscaping works.	Nepean Hospital Campus – bounded by the Great Western Highway and Barber Avenue to the north, Somerset Street to the east, Derby Street to the south and Parker Street to the west.	Approximately 600 metres south-west of the proposal site	Response to submissions/more information required

Name of project	Description	Address	Distance from proposal	Status
TAFE NSW Institute of Applied Technology	Expansion if the TAFE including earthworks and tree removal, construction of a three-storey building, additional car park/loading area, substation and landscaping	2-44, Connell Street, Kingswood	Approximately 1.5 kilometres south-east of the proposal site	Approved 2021

6.13.2 Potential impacts

Potential cumulative impacts may occur as a result of construction activities occurring at the same time as any of the projects listed in Table 6.26. Potential impacts would include:

- increased traffic travelling through the study area and surrounding road network and associated delays for road users
- increased construction vehicles on local roads
- construction noise and vibration
- reduced visual amenity.

Based on this assessment, it is anticipated that the cumulative impacts would be minor, provided that consultation with relevant stakeholders and mitigation measures are implemented.

6.13.3 Mitigation measures

Consultation and liaison would occur with Penrith City Council, Sydney Trains and any other developers identified, to minimise cumulative construction impacts such as traffic and noise.

The proposed mitigation measures are outlined in Table 6.27.

Table 6.27 Cumulative mitigation measures

ID	Mitigation measure	Stage
CI1	Consultation will occur with other construction contractors in the area to minimise potential cumulative impacts on the community.	Pre-construction/ Construction

7 Environmental management

7.1 Environmental management plans

A CEMP for the construction stage of the proposal would be prepared. The CEMP would incorporate as a minimum all environmental mitigation measure identified below.

No additional licences or approvals are considered necessary.

It is understood that further refinement of the design is occurring. A consistency assessment would be prepared to confirm that the final proposal is consistent with this REF and to determine if additional investigations and/or an addendum REF are required.

7.2 Mitigation measures

Mitigation measures for the proposal are listed in Table 7.1. These proposed measures would minimise the potential adverse impacts of the proposal identified in Chapter 6.

The proposed key sustainability initiatives to be implemented include:

- vertical plantings on the facade, selected with consideration of the proposed design and species to suit western Sydney's climate
- rainwater tanks for landscape irrigation and toilet flush
- water efficient systems and fixtures
- solar panels on the rooftop
- energy efficient LED lighting
- consider the Life Cycle of all materials – select materials with a low embodied energy, that are durable, low maintenance, have a recycled content, that can be recycled, that have buy back or reuse schemes
- all concrete to have a recycled content and use recycled aggregate wherever practicable.

Table 7.1 Proposed mitigation measures

ID	Mitigation measure	Stage
Traffic and transport		
T1	A Construction Traffic Management Plan (CTMP) will be prepared as part of the CEMP and implemented during construction. The CTMP will be developed in consultation with Penrith City Council and Transport for NSW and include at a minimum: — adequate signage to inform motorists and pedestrians of the work site and the change in road conditions — maximising safety and accessibility for pedestrians and cyclists — ensuring adequate sight lines to allow for safe entry and exit from the site — traffic controls to manage deliveries — management of the temporary kiss and ride on Richmond Road — ensuring access is maintained to Kingswood Station and the adjacent Transport for NSW car park — parking locations for construction workers away from the station and promotion of use of public transport by workers and details of how this would be monitored for compliance — required regulatory and direction signposting, line marking and variable message signs and all other traffic control devices necessary for the implementation of the CTMP. For surrounding projects that may be under construction concurrently with the proposal, consultation will also be undertaken with the proponent(s) to consider opportunities to reduce cumulative impacts of construction traffic. The performance of all project traffic arrangements must be monitored during construction.	Pre-construction/ Construction
T2	Penrith City Council will monitor the performance of the following intersections to determine if intersection modifications are required post construction of the Kingswood commuter car park based on safety concerns, additional development in the area or any other determining factors: — Cox Avenue and Richmond Road — Copeland Street and Phillip Street — Copeland Street and Richmond Road — Victoria Street and Heath Street — Parker Street and Copeland Street intersection requires further assessment by Penrith City Council for traffic not generated by the proposal, as the traffic impact assessment found that the intersection would be operating over capacity in 2033 from predicted traffic growth.	Operation
T3	Penrith City Council will monitor the key roads during operation of the Kingswood commuter car park to determine whether: — the speed limit is suitable for the environment with during operation of the proposal — additional infrastructure is required to assist vehicular and pedestrian movements along and across the key roads adjacent the proposal.	Operation
T4	Penrith City Council will provide a copy of the determination to Transport for NSW within seven days of the determination.	Operation

ID	Mitigation measure	Stage
Landscape and visual		
LV1	All permanent lighting will be designed and installed in accordance with the Penrith City Council – Public Domain Lighting Policy – PDAS 003, Transport for NSW requirements and the requirements of standards relevant to AS 1158 Road Lighting and AS 4282 Controlling the Obtrusive Effects of Outdoor Lighting.	Detailed design
LV2	The detailed design of the proposal will incorporate the Crime Prevention Through Environmental Design (CPTED) principles	Detailed design
LV3	Worksite compounds will be screened with shade cloth (or similar material) to minimise visual impacts from key viewing locations, e.g. from the station.	Construction
LV4	Temporary hoardings, barriers, traffic management and signage will be removed when no longer required.	Construction
LV5	Graffiti will be removed in accordance with Transport for NSW's Standard Requirements.	Construction
LV6	Temporary access arrangements will be well signed and provide a visually legible route for pedestrians.	Construction
LV7	Construction equipment and activity will be consolidated to maximise the area of useable public realm where practicable.	Construction
LV8	All working areas will be maintained, kept free of rubbish and cleaned up at the end of each working day. Equipment and materials will be securely stored.	Construction
LV9	Vertical planting and landscaping will be maintained for the life of the car park.	Operation
Noise and vibration		
NV1	Prior to commencement of works, a Construction Noise and Vibration Management Plan (CNVMP) will be prepared as part of the CEMP and be implemented in accordance with the requirements of the ICNG. The CNVMP will take into consideration measures for reducing the source noise levels of construction equipment by construction planning and equipment selection where practicable. Reasonable and feasible noise mitigation measures which will be considered include: — avoiding/limiting simultaneous operation of noisy plant in discernible range of a sensitive receiver where practicable — switching off any equipment not in use for extended periods e.g. heavy vehicles engines would be switched off whilst being unloaded — restriction of heavy vehicle movements to and from the site to standard (daytime) hours where feasible and avoiding deliveries at night/evenings wherever practicable — no idling of delivery trucks — keeping truck drivers informed of designated routes, parking locations and acceptable delivery hours for the site — compounds, refuelling areas and work areas designed to promote one-way traffic so that vehicle reversing movements are minimised — maximising offset distances between noisy plant and adjacent sensitive receivers and determining safe working distances — using the most suitable equipment necessary for the construction works at any one time — directing noise-emitting plant away from sensitive receivers	Pre-construction/ Construction

ID	Mitigation measure	Stage
	— regularly inspecting and maintaining plant to avoid increased noise levels from rattling hatches, loose fittings etc — using non-tonal reversing/movement alarms such as broadband (non-tonal) alarms or ambient noise-sensing alarms for all plant used regularly onsite (greater than one day), and for any out of hours works.	
NV2	During SC01 (site establishment), temporary barriers will be erected to ensure that work will be conducted behind temporary hoardings/screens wherever practicable. The installation of construction hoarding will take into consideration the location of sensitive receivers to ensure that 'line of sight' is broken, where feasible. This has the potential to reduce noise levels between 5 and 10 dB.	Construction
NV3	During SC02 (demolition) to SC06 (precinct works), the concrete saw is the main contributor to construction noise. Without the concrete saw, the total activity noise level is reduced by 6–8 dB. It is recommended that the use of these plant items is limited where possible, and works are undertaken during Standard Hours. Where work is required outside of standard hours, the use of this equipment will avoid sensitive periods such as after midnight and before 7 am.	Construction
NV4	Due to the high exceedances of NMLs during SC02 (demolition) to SC06 (precinct works), when a concrete saw is to be used near sensitive receivers a temporary screen or enclosure (10–15 dB reduction) will be placed around the works in conjunction with temporary barriers.	Construction
NV5	Activities at the nearest residential receivers are likely to fluctuate over the course of the day, therefore, Council will with operators to determine feasible construction staging to manage impacts, effectively communicate likely impacts, potential periods of high intensity works, and to develop a schedule of consultation to program intensive works outside the most active periods. Respite periods will be negotiated and a community consultation strategy developed to ensure a complaints hotline and feedback pathway is established.	Construction
NV6	Works will generally be carried out during standard construction hours (i.e. 7.00 am to 6.00 pm Monday to Friday; 8.00 am to 1.00 pm Saturdays). Any works outside these hours may be undertaken if approved by Council and the community is notified prior to these works commencing. A detailed noise assessment will be prepared prior to any out of hours activities.	Construction
NV7	Where the construction noise levels are predicted to exceed 75 dBA and/or 30 dB above the Rating Background Level at nearby affected sensitive receivers, respite periods will be observed, where practicable, and in accordance with the Construction Noise and Vibration Strategy (Transport for NSW, 2019). This will include restricting the hours that very noisy activities can occur.	Construction
NV8	Where different vibration intensive equipment or different construction work areas are proposed, the vibration impacts must be reassessed.	Construction
NV9	Construction Traffic Management Plan will be developed and its findings used to inform the CNVMP. This will include delivery schedules, speed limits and circulation recommendations (measures to promote one-way traffic).	Construction

ID	Mitigation measure	Stage
NV10	Detailed design of the proposal will consider implementation of the following: — avoidance of polished concrete floors — soft closing mechanisms for stairwell doors — fully concrete or rubber speedbumps, where practicable. Mechanical plant selected must comply with the sound data provided in Table 6.10. Where additional/alternative mechanical plant and equipment is proposed, the operational noise assessment must be updated by a qualified acoustic consultant.	Detailed design
Socioeconomic impacts		
SE1	Impacts to the community will be managed through the implementation of a Community Liaison Management Plan (CLMP) before, during and after consultation.	Pre-construction/ Construction/ Operation
SE2	Communities will continue to be engaged throughout the proposal to be kept up to date, and a 24-hour contact will be available to contact with any questions or concerns.	Pre-construction/ Construction/ Operation
Biodiversity		
B1	Disturbance of vegetation will be limited to the minimum amount necessary to construct the proposal. Trees nominated for removal will be clearly demarcated onsite prior to construction. Tree protection will be undertaken in line with AS 4970-2009 Protection of Trees on Development Sites. Trees to be retained will be protected through temporary tree protection fencing and trunk protection battens. Access will be controlled so that movement does not occur through any tree protection areas.	Pre-construction/ Construction
B2	All workers will be provided with an environmental induction prior to commencing work onsite. This induction will include information on the protection measures to be implemented to protect trees.	Construction
B3	Access will be controlled so that movement does not occur through any tree protection areas.	Construction
B4	The demolition of the existing concrete footpath adjacent to the trees to be retained will be overseen by a qualified arborist to ensure roots growing below or adjacent to the path are adequately protected.	Construction
B5	The storage or stockpiling of any materials will avoid the tree protection areas.	Construction
Aboriginal heritage		
AH1	The proposed works will proceed at the Kingswood commuted car park without further archaeological investigation under the following conditions: — All land and ground disturbance activities will be confined to within the study area, as this will eliminate the risk of harm to Aboriginal objects in adjacent landforms. Should the parameters of the project extend beyond the assessed areas, then further archaeological assessment will be required — All staff and contractors involved in the proposed work will be made aware of the legislative protection requirements for all Aboriginal sites and objects.	Pre-construction/ Construction

ID	Mitigation measure	Stage
AH2	An Unanticipated Finds Protocol will be developed and included in the CEMP to provide a consistent method for managing any unexpected Aboriginal heritage items discovered during construction, including potential heritage items or objects, and human skeletal remains.	Pre-construction/ Construction
AH3	This assessment has concluded that there is a low likelihood that the proposed work will adversely harm Aboriginal cultural heritage items or sites. If during works, however, Aboriginal artefacts or skeletal material are noted, all work will cease and the procedures in the Unanticipated Finds Protocol will be followed.	Construction
AH4	Inductions for construction workers will include a cultural heritage awareness procedure to assist with recognising Aboriginal artefacts and construction workers are aware of the legislative protection of Aboriginal objects under the *National Parks and Wildlife Act 1974* and the contents of the Unanticipated Finds Protocol.	Construction
AH5	The information presented here meets the requirements of the Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales. It will be retained as shelf documentation for five years as it may be used to support a defence against prosecution in the event of unanticipated harm to Aboriginal objects.	Construction / Operation
Non-Aboriginal heritage		
H1	An Unanticipated Finds Protocol will be developed and included in the CEMP to provide a consistent method for managing any unexpected non-Aboriginal heritage items discovered during construction.	Pre-construction/ Construction
H2	Any unexpected archaeological deposits will be managed in accordance with relevant legislation and stop-work procedures to be prepared by the contractor and included in the CEMP.	Pre-construction/ Construction
Soils and contamination		
S1	An Unexpected Finds Protocol will be prepared and implemented as part of the CEMP to assess and manage unexpected finds of contamination during development.	Pre-construction/ Construction
S2	A Licensed Asbestos Assessor will be engaged to assess exposed fill soil surfaces on site, following removal of the existing bitumen and subgrade, prior to excavation of any fill material. The Licensed Asbestos Assessor will inspect the soil surfaces in order to identify any potential ACM and provide further direction (i.e. approval to excavate or recommendations in the event that ACM is encountered).	Construction
S3	Testing will be conducted by an environmental consultant, prior to any waste being taken off-site to a licenced disposal facility.	Construction
S4	An Erosion and Sediment Control Plan (ESCP) will be implemented during construction of the proposal to mitigate impacts to soils and erosion during excavation and earthworks.	Construction
S5	Fuels, oils and other chemicals will be stored at an appropriate bunded location and away from waterways or stormwater drains.	Construction
S6	Refuelling of construction machinery and vehicles will take place at an appropriate location away from waterways or stormwater drains.	Construction

ID	Mitigation measure	Stage
Hydrology and water quality		
SW1	An Erosion and Sediment Control Plan will be prepared and implemented for the proposal to manage risks to water quality. The plan will be prepared in accordance with best onsite practice, reflected in Managing Urban Stormwater–Soils and Construction, Volume 1 (Landcom, 2004) and Volumes 2A and 2C (DECC, 2008) also known as 'The Blue Book'.	Pre-construction/ Construction
SW2	All material will be swept, removed and deposited onto the access roads at the end of each working shift and before rainfall.	Construction
SW3	Construction workers will routinely check and record that all erosion and sediment controls are maintained and effective and undertake additional inspections following a rainfall event of 10 millimetres or greater.	Construction
SW4	Emergency spill kits will be kept onsite always and make all staff aware of their location and trained in their use.	Construction
SW5	Should groundwater be encountered during excavation works, groundwater will be managed in accordance with the requirements of the *Waste Classification Guidelines* (EPA, 2014) and Transport for NSW's *Water Discharge and Reuse Guideline* (TfNSW, 2019).	Construction
Air quality		
AQ1	Methods for management of emissions will be incorporated into project inductions, training and pre-start/toolbox talks.	Construction
AQ2	Plant and machinery will be regularly checked and maintained in a proper and efficient condition. Plant and machinery will be switched off when not in use, and not left idling.	Construction
AQ3	Vehicle and machinery movements during construction will be restricted to designated areas and sealed/compacted surfaces where practicable.	Construction
AQ4	To minimise the generation of dust from construction activities, the following measures will be implemented: — apply water (or alternate measures) to exposed surfaces (e.g. unpaved roads, stockpiles, hardstand areas and other exposed surfaces) — cover stockpiles when not in use — appropriately cover loads on trucks transporting material to and from the construction site and securely fix tailgates of road transport trucks prior to loading and immediately after unloading — prevent mud and dirt being tracked onto sealed road surfaces.	Construction
Waste		
W1	A Waste Management Plan will be prepared and implemented as part of the construction environmental management plan. The WMP will outline: — method of containment and/or treatment of contaminated soil — adequate safe removal techniques — management measures to prevent the spread of contamination — location of acceptable waste facility — measures of transport of material to ensure loads are covered and waste is not dispersed during transport.	Pre-construction/ Construction

ID	Mitigation measure	Stage
W2	All materials excavated (soils and sediments) will be tested in accordance with the *NSW EPA Waste Classification Guidelines Part 1: Classifying Waste* (2014a).	Construction
W3	The contractor will be appropriately licensed to remove and dispose of any potential hazardous materials in accordance with relevant guidelines and regulations. Potential hazardous materials will be handled and disposed in accordance with relevant Australian Standards, WorkCover and regulatory agency (EPA) guidelines.	Construction
W4	All waste fluids generated during the works, including from the washing of painting equipment, will be contained for proper disposal offsite. Cleaners, solvents, paints or other inorganic liquids will not be disposed on site.	Construction
W5	All waste removal, transport and disposal, including excess spoil, will be in accordance with the EPA's current guidelines for waste. Materials will be recycled wherever possible. Dockets or equivalent evidence will be obtained for all recycling and waste disposal, detailing the weights, materials, time and date and waste facility used.	Construction
W6	An Operational Waste Management Plan will be prepared to manage waste for the proposal.	Operation
Climate change		
CC1	Detailed design of the proposal will be undertaken in accordance with the *NSW Sustainable Design Guidelines – Version 4.0* (Transport for NSW, 2019a). The proposal will include sustainability measures such as: — vertical plantings including automatic watering system — rainwater tanks for landscape irrigation and toilet flush — roof shading 99 kilowatt solar panels to the rooftop — energy efficient LED lighting — electric vehicle charging — possible adoption of modular design and construction methods such as 'green concrete' that provides carbon savings.	Pre-construction
CC2	Materials will be selected materials for durability in extreme conditions that minimise heat retention.	Pre-construction
CC3	Engineering and design features will be incorporated to ensure structures are constructed to minimise direct impacts from severe storms and strong winds.	Pre-construction
Cumulative impacts		
CI1	Consultation will occur with other construction contractors in the area to minimise potential cumulative impacts on the community.	Pre-construction/ Construction

8 Justification and conclusion

8.1 Justification

The proposal would substantially increase commuter car parking in Kingswood, support increased use of public transport and ease future urban congestion, while at the same time improve public amenity through the integration of vertical plantings and landscaping. These inclusions would improve visual amenity of the proposal for car park users and neighbours.

8.2 Conclusion

This REF has been prepared in accordance with the provisions of Section 5.5 of the EP&A Act and the REF Procedure (Penrith City Council, 2021), taking into account all matters affecting or likely to affect the environment as a result of the proposal.

The following key impacts have been identified during construction and operation of the proposal:

- temporary noise, traffic and visual impacts during construction
- removal of around 27 trees
- long term changes to the visual environment.

Based on the assessment contained in this REF, it is considered that the proposal is not likely to have a significant impact upon the environment, or any threatened species, populations or communities or their habitats. Accordingly, an EIS is not required, nor is the approval of the Minister for Planning and Homes. It is understood that further refinement of the design is occurring. A consistency assessment would be prepared to confirm that the final proposal is consistent with this REF and to determine if additional investigations and/or an addendum REF are required.

9 References

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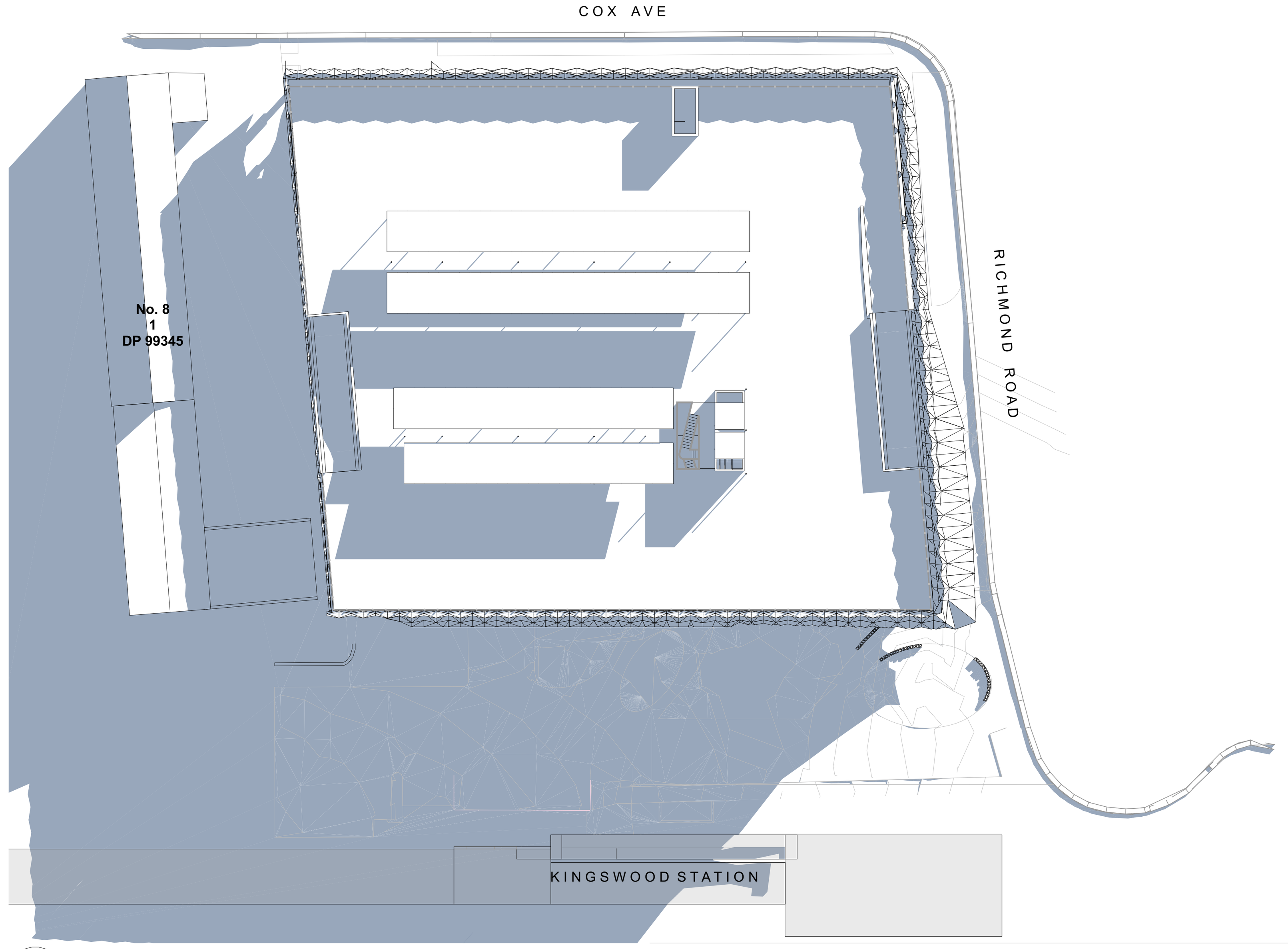
Appendix A

Concept design



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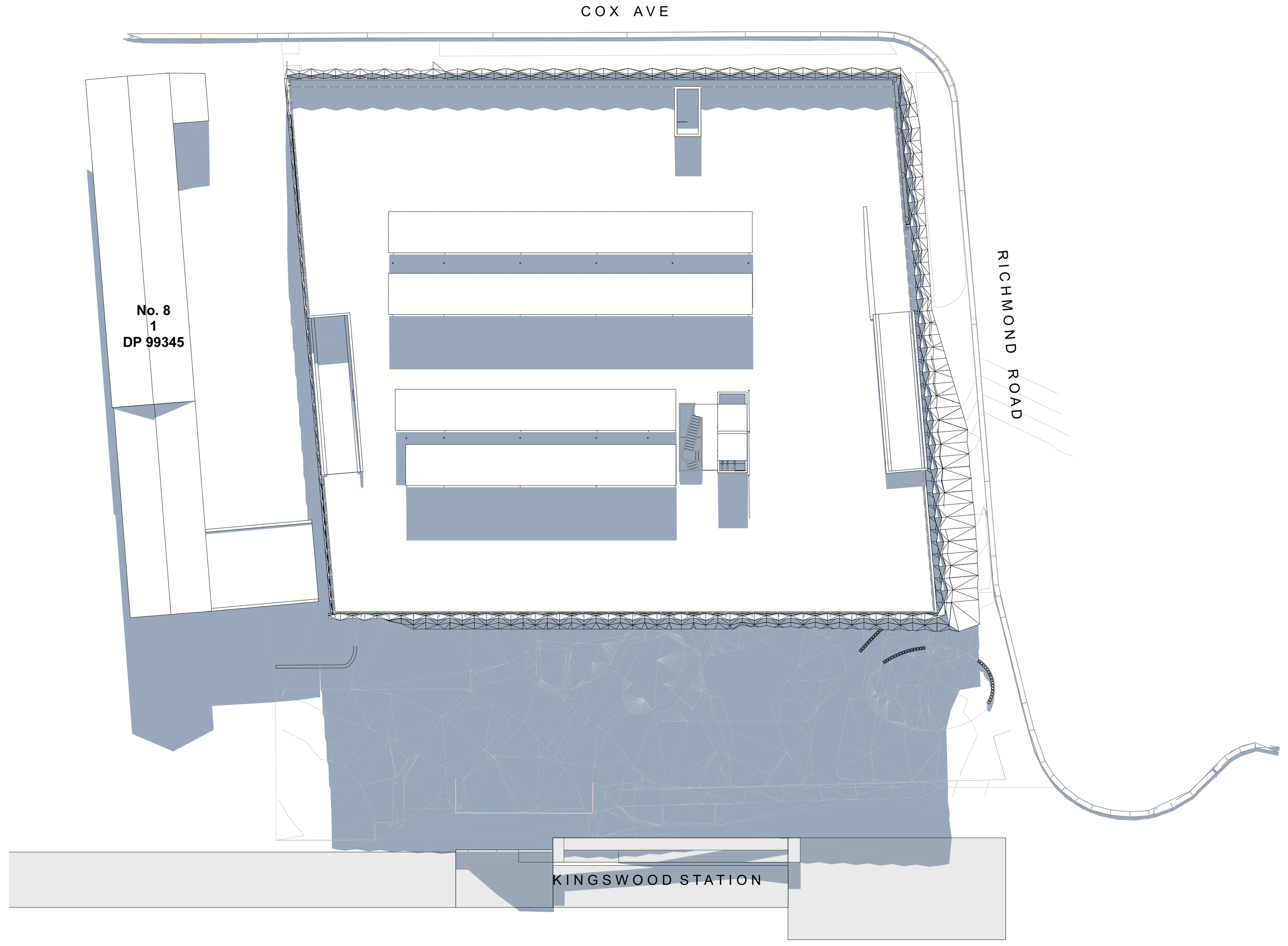

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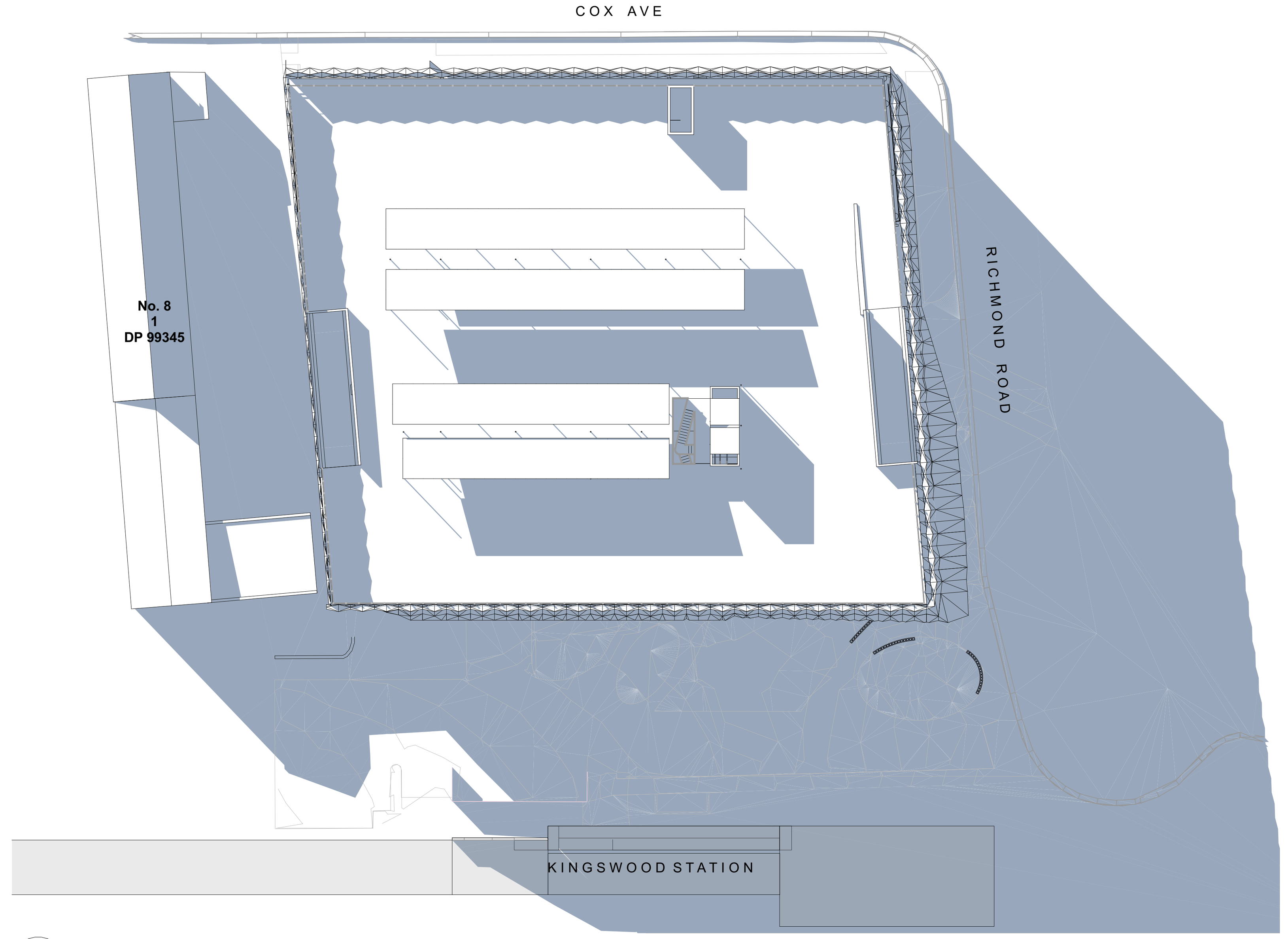

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ISSUED FOR INFORMATION

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DESCRIPTION	REV	APP'D	DATE
FOR COORDINATION	01	SC	17/05/2022

CLIENT
PENRITH CITY COUNCIL

PROJECT
KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT

SCALE @ A1

SCALE @ A3
1:400

PROJECT NO.	STAGE	DRAWING NO.	REV
21.14	SK	8.7	**01**

DRAWING TITLE
SHADOW DIAGRAMS

CONCEPT DRAWINGS FOR

6 COX AVENUE KINGSWOOD NSW 2747

FOR PENRITH CITY COUNCIL

CONCEPT DESIGN: DRAWING LIST

DRAWINGS		
00	COVER PAGE	
PLANS		
01	LG FLOOR	1:200
02	GROUND FLOOR	1:200
03	FIRST- SECOND FLOOR	1:200
04	THIRD FLOOR/ ROOF PLAN	1:200
05	LG FLOOR/ PUBLIC REALM	1:200
SECTIONS		
06	SECTIONS	1:200
PERSPECTIVES		
07A	ART. IMPRESSION FROM S.E.	
07B	ART. IMPRESSION FROM S.E.	
08	ART. IMPRESSION FROM N.E.	
MATERIALS, LANDSCAPING, INTEGRATED ART/ WAYFINDING		
09	MATERIALS STUDY	
10	LANDSCAPING STUDY	
11	INTEGRATED ART STUDY	

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0 2 4 8 20 AT **A3**

LYMESMITH Polychromy

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DESCRIPTION	REV	APP'D	DATE
ISSUED FOR REVIEW	P1	SC	8/04/2022
ISSUED FOR INFORMATION	P2	SC	19/04/2022

CLIENT
PENRITH CITY COUNCIL
PROJECT
KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT
SCALE @ A1
SCALE @ A3

PROJECT NO.	STAGE	DRAWING NO.	REV
21.14	SK	00	**P2**

DRAWING TITLE
COVER PAGE

01 LOWER GROUND FLOOR
1:200

LEGEND

LANDSCAPING

- TREE RETAINED
- TREE PROPOSED
- PROPOSED LANDSCAPED AREA
- NEW HARDSCAPED AREA
- PERMEABLE PAVING
- PEDESTRIAN LEVEL PATHWAY
- REMOVED OR DEMOLISHED

STRUCTURE

- STRUCTURE
- COLUMNS IN ALIGNMENT WITH LEVELS ABOVE
- COLUMNS ABOVE TRANSFER
- SHEER WALL

OTHER

- BIN STORAGE LOCATION. SIZES TBC
- SERVICES/ UTILITIES
- BOOM GATE

CAR PARKING

3RD	93
2ND	93
1ST	93
G	81 (Inc. Accessible)
LG	62 (Inc. Accessible)
TOTAL	422

Printed: 12:19 PM, 21/7/2022

CONCEPT DESIGN

0 1 2 4 10 AT A1
0 2 4 8 20 AT A3

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DESCRIPTION	REV	APP'D	DATE
ISSUED FOR REVIEW	P1	SC	8/4/2022
ISSUED FOR INFORMATION	P2	SC	19/4/2022
ISSUED FOR INFORMATION	P3	SC	22/4/2022

CLIENT
PENRITH CITY COUNCIL

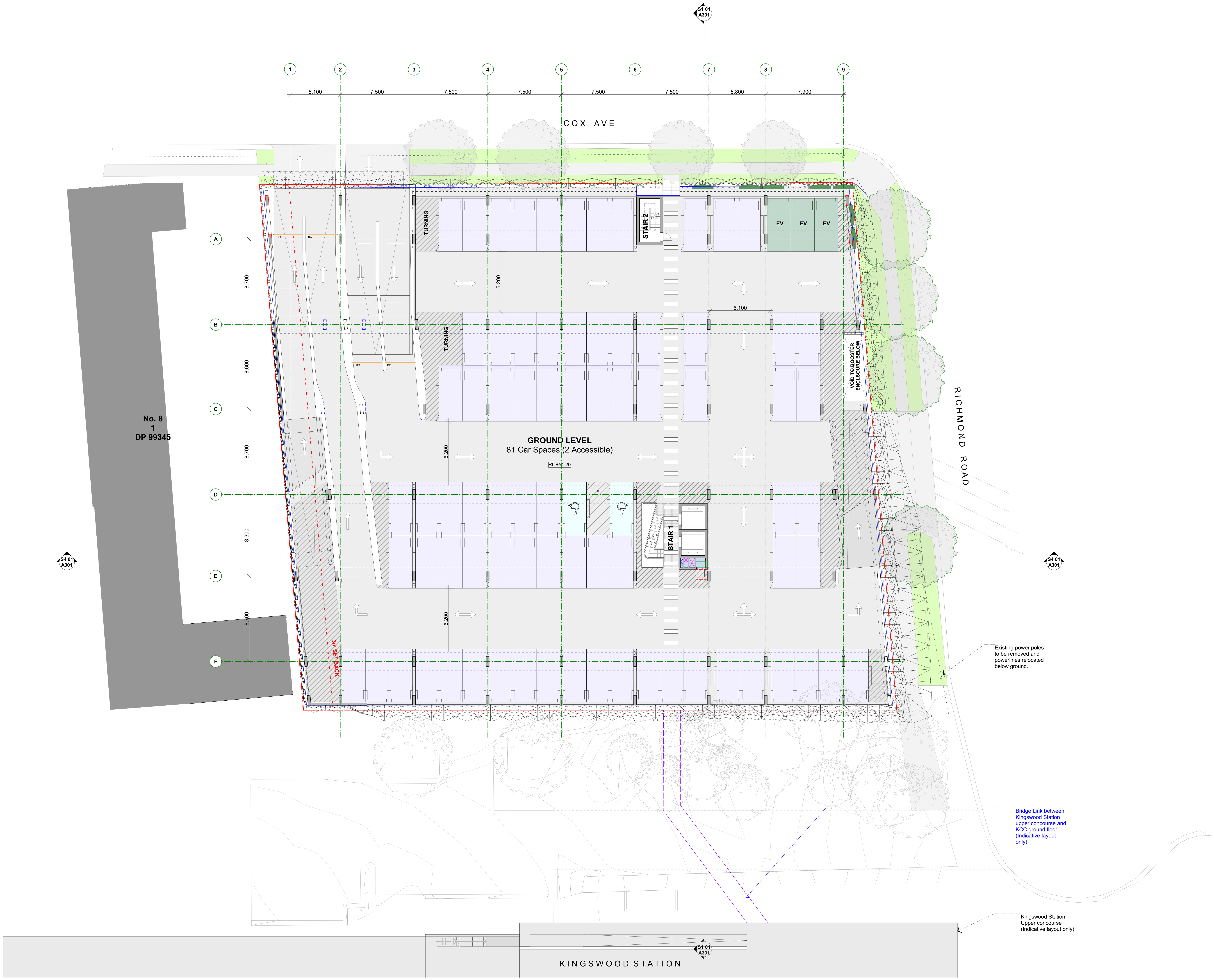
PROJECT
KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT

SCALE @ A1	PROJECT NO.	STAGE	DRAWING NO.	REV
1:200	21.14	SK	01	P3

SCALE @ A3
1:400

DRAWING TITLE
LG FLOOR



01 **GROUND FLOOR - BASE CASE**
1:200

LEGEND

LANDSCAPING

- TREE RETAINED
- TREE PROPOSED
- PROPOSED LANDSCAPED AREA
- NEW PAVED/ HARDSCAPED AREA
- PEDESTRIAN LEVEL PATHWAY

STRUCTURE

- STRUCTURE
- COLUMNS IN ALIGNMENT WITH LEVELS ABOVE
- COLUMNS ABOVE TRANSFER
- SHEER WALL

OTHER

- BIN STORAGE LOCATION. SIZES TBC
- SERVICES/ UTILITIES
- BOOM GATE
- PLANTER BOX

CAR PARKING

3RD	93
2ND	93
1ST	93
G	81 (Inc. Accessible)
LG	62 (Inc. Accessible)
TOTAL	422

CONCEPT DESIGN

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0 2 4 8 20 AT **A3**

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DESCRIPTION	REV	APP'D	DATE
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ISSUED FOR INFORMATION	P2	SC	19/04/2022
ISSUED FOR INFORMATION	P3	SC	22/04/2022

CLIENT
PENRITH CITY COUNCIL

PROJECT
KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT

SCALE @ A1	PROJECT NO.	STAGE	DRAWING NO.	REV
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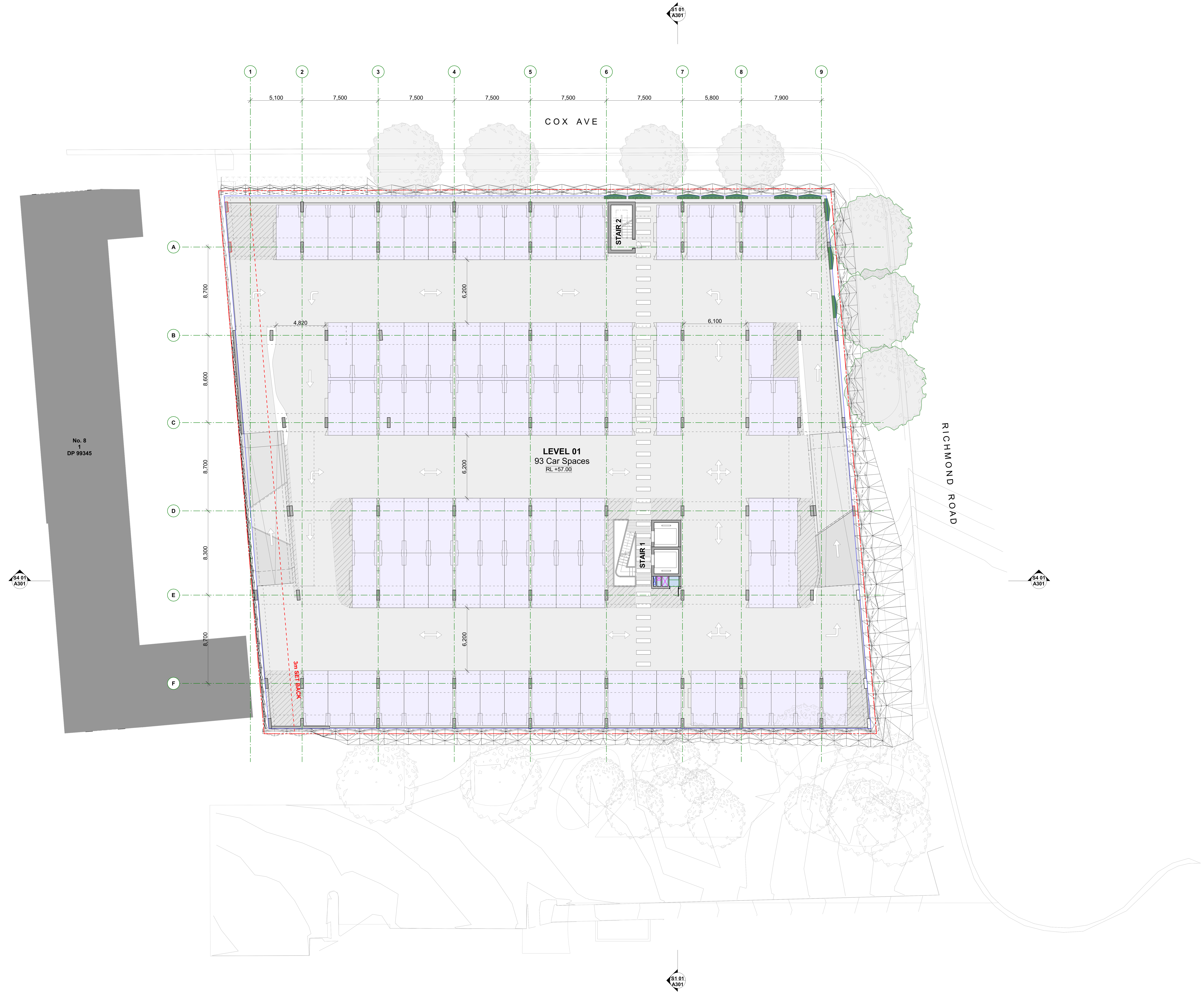
SCALE @ A3
1:400

DRAWING TITLE
GROUND FLOOR



LEGEND

STRUCTURE

- STRUCTURE
- COLUMMS IN ALIGNMENT WITH LEVELS ABOVE
- SHEER WALL

CAR PARKING

3RD	93
2ND	93
1ST	93
G	81 (Inc. Accessible)
LG	62 (Inc. Accessible)
TOTAL	422

01 **FIRST-SECOND FLOOR PLAN**
1:200

CONCEPT DESIGN

0 1 2 4 10 AT A1
0 2 4 8 20 AT A3

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DESCRIPTION	REV	APP'D	DATE
ISSUED FOR REVIEW	P1	SC	8/04/2022
ISSUED FOR INFORMATION	P2	SC	19/04/2022
ISSUED FOR INFORMATION	P3	SC	22/04/2022

CLIENT
PENRITH CITY COUNCIL

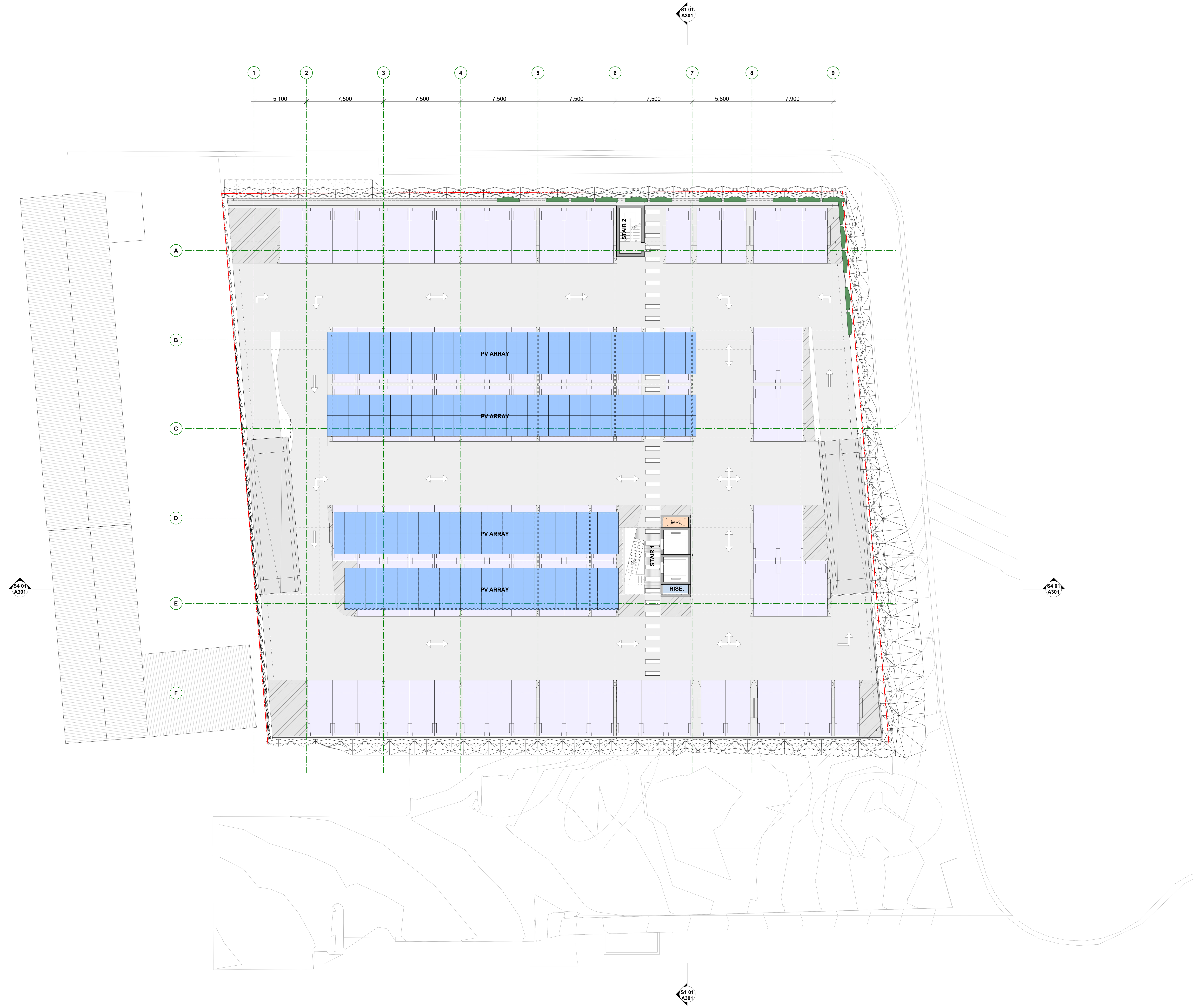
PROJECT
KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT

SCALE @ A1	PROJECT NO.	STAGE	DRAWING NO.	REV
1:200	21.14	SK	03	P3

SCALE @ A3
1:400

DRAWING TITLE
FIRST- SECOND FLOOR



LEGEND

STRUCTURE

- STRUCTURE
- COLUMMS IN ALIGNMENT WITH LEVELS ABOVE
- COLUMMS ABOVE TRANSFER
- SHEER WALL
- PV ARRAY (246 PANELS TOTAL)

CAR PARKING

3RD	93
2ND	93
1ST	93
G	81 (Inc. Accessible)
LG	62 (Inc. Accessible)
TOTAL	422

01 **FIRST-SECOND FLOOR PLAN**
1:200

CONCEPT DESIGN

0 1 2 4 10 AT **A1**
0 2 4 8 20 AT **A3**

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ISSUED FOR INFORMATION	P3	SC	22/04/2022

CLIENT
PENRITH CITY COUNCIL

PROJECT
KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT	SCALE @ A1	PROJECT NO.	STAGE	DRAWING NO.	REV
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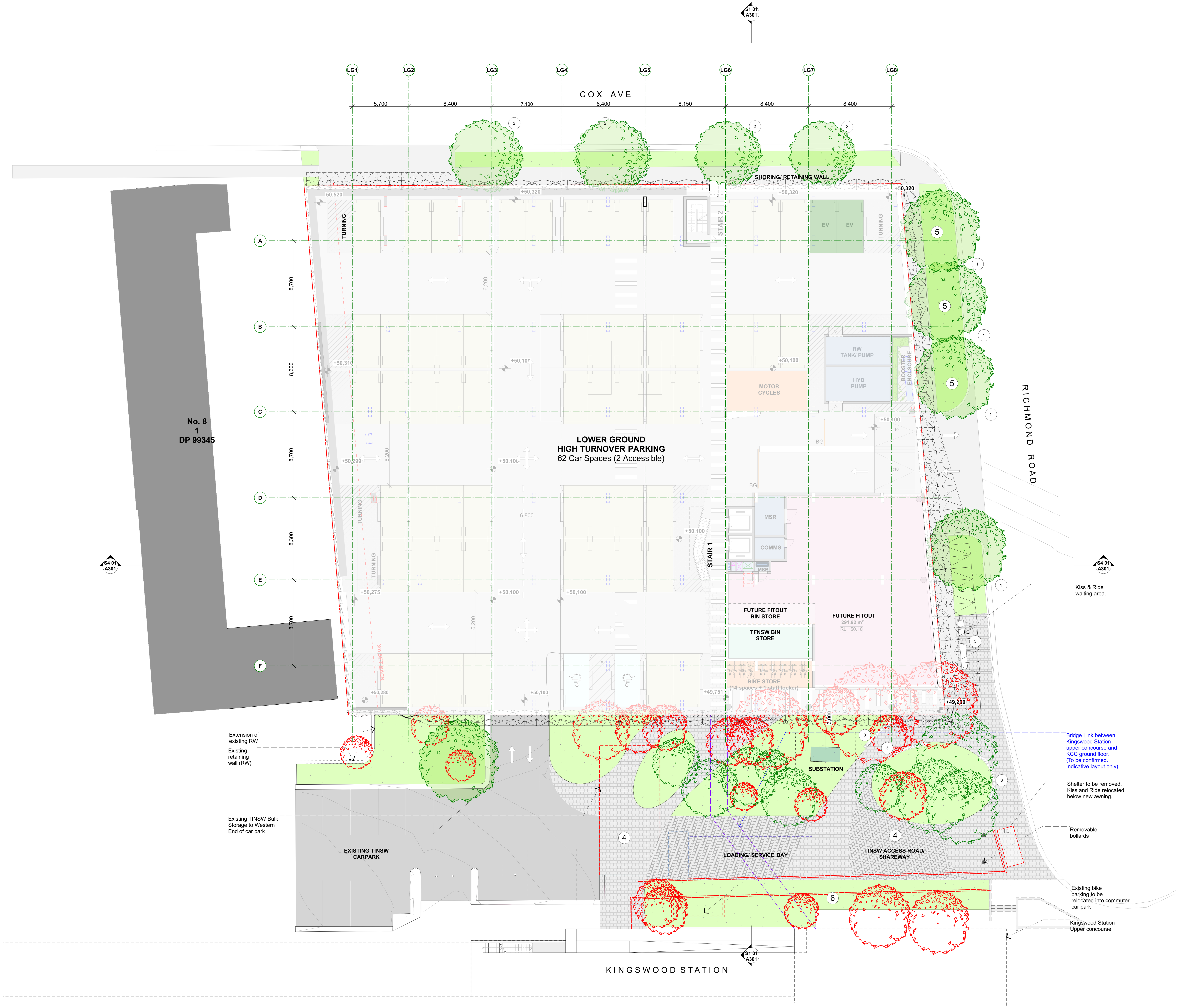
11:39 AM, 22/04/2022



LEGEND

LANDSCAPING

- TREE RETAINED
- TREE PROPOSED
- TREE REMOVED
- PROPOSED LANDSCAPED AREA
- NEW PAVED/ HARDSCAPED AREA
- PEDESTRIAN LEVEL PATHWAY
- REMOVED OR DEMOLISHED

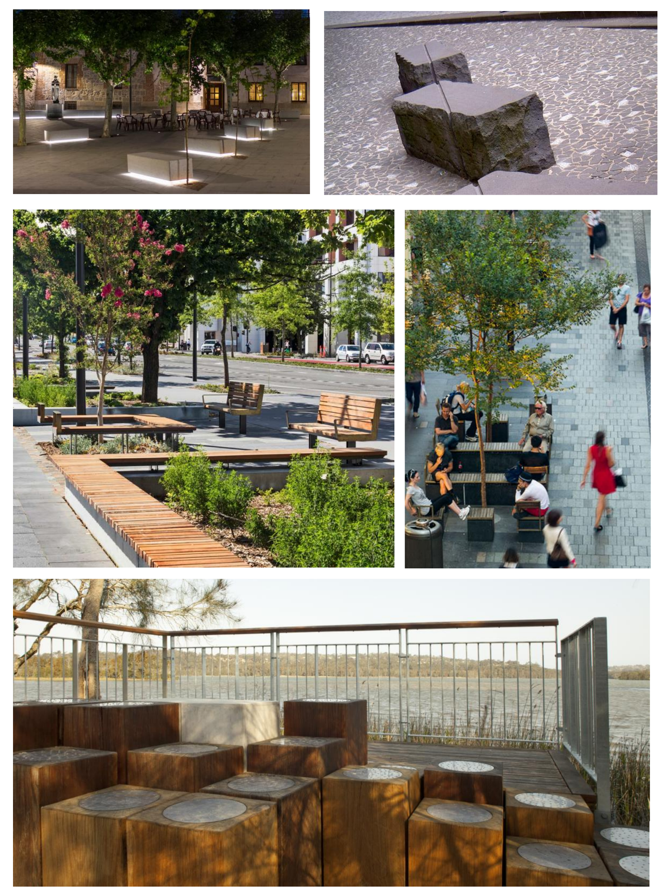
01 LOWER GROUND FLOOR - TfNSW PUBLIC REALM
1:200

TREES TO STREETSCAPE

1 Lophostemon confertus (Brushbox)

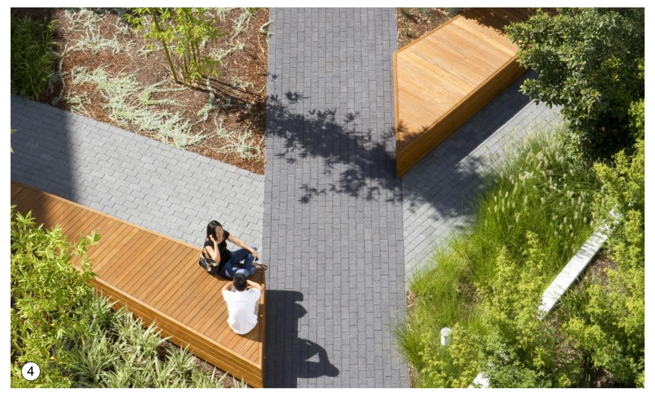
2 Corymbia_maculata (Spotted Gum)

ROBUST SEATING 3



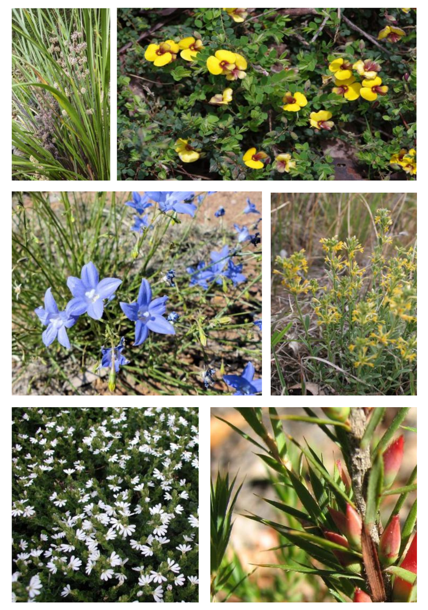
KERB/ STORMWATER MANAGEMENT

PERMEABLE PAVING



WSUD RAINWATER TREE PITS & GARDEN

CUMBERLAND PLAIN PLANTING



CONCEPT DESIGN

DESCRIPTION	REV	APP'D	DATE
ISSUED FOR REVIEW	P1		8/04/2022
ISSUED FOR INFORMATION	P2	SC	19/04/2022
ISSUED FOR INFORMATION	P3	SC	22/04/2022

CLIENT: PENRITH CITY COUNCIL

PROJECT: **KINGSWOOD COMMUTER CARPARK**
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT	SCALE @ A1	PROJECT NO.	STAGE	DRAWING NO.	REV
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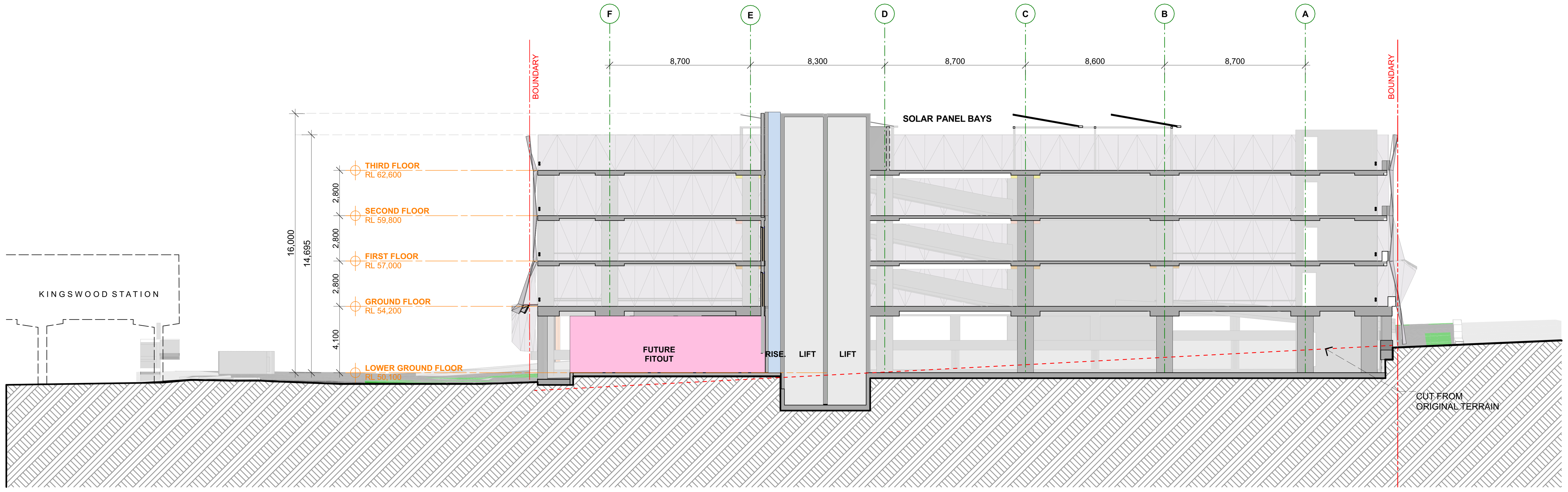
	SCALE @ A3 1:400	DRAWING TITLE: LG FLOOR/ PUBLIC REALM			

LOCI

samcrawfordarchitects



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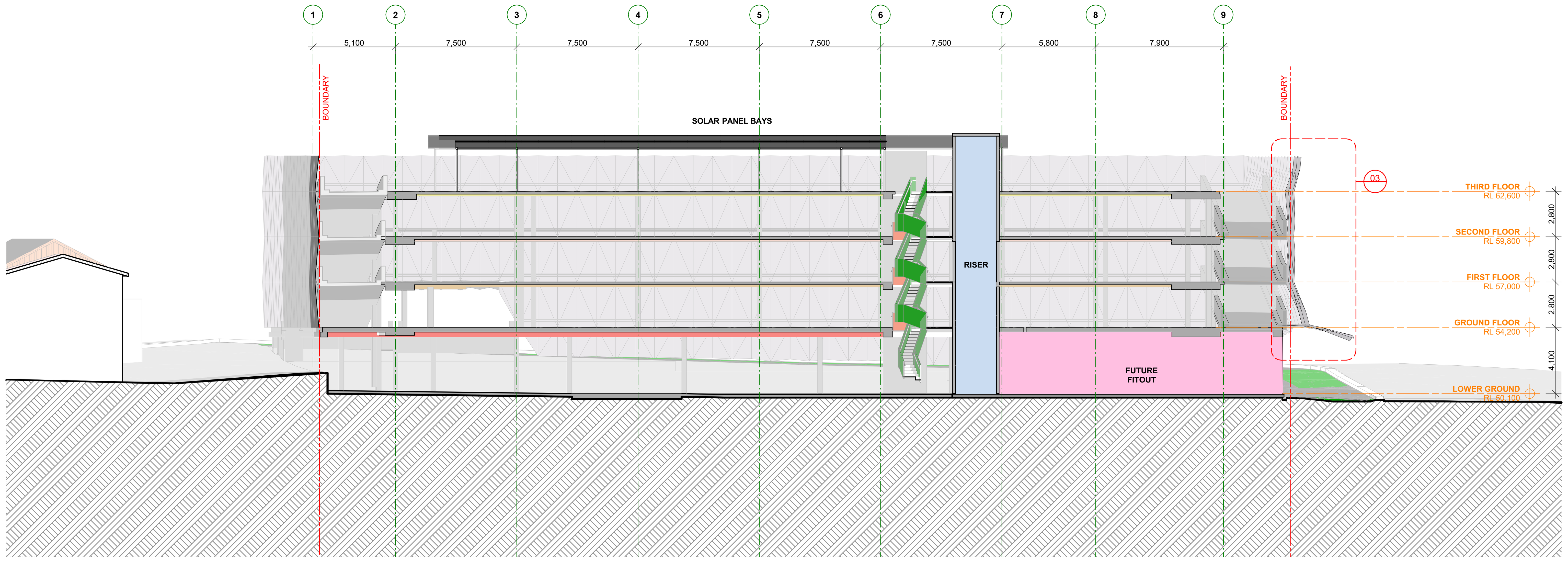

02 SECTION BB
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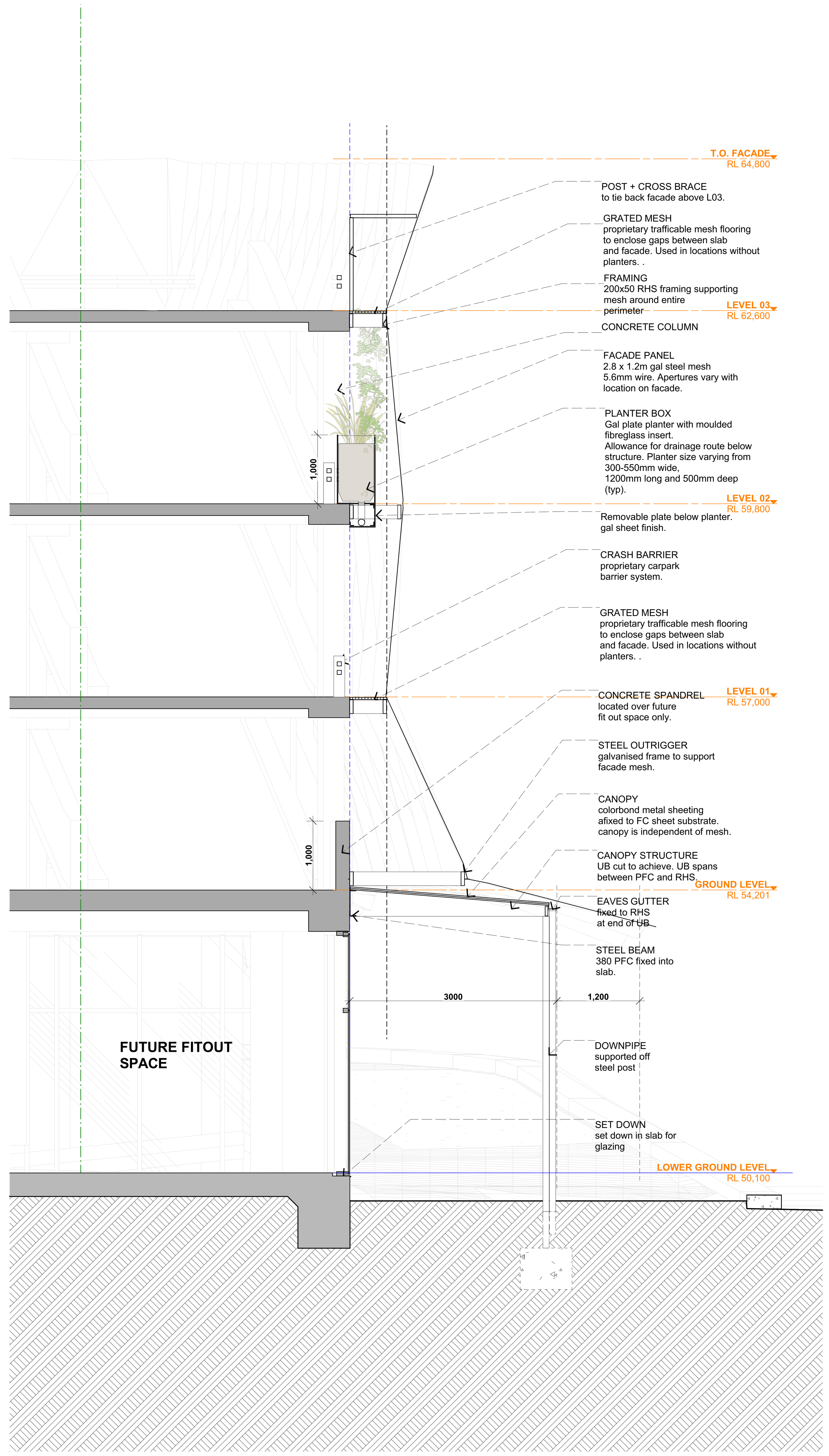

03 CANOPY SECTION DETAIL
1:50

CONCEPT DESIGN

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0 2 4 8 20 AT A3

LOCI

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DESCRIPTION	REV	APP'D	DATE
ISSUED FOR REVIEW	P1	SC	8/4/2022
ISSUED FOR INFORMATION	P2	SC	19/4/2022

CLIENT
PENRITH CITY COUNCIL
PROJECT
KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT

SCALE @ A1	PROJECT NO.	STAGE	DRAWING NO.	REV
1:200	21.14	SK	06	P2

SCALE @ A3
1:100
DRAWING TITLE
SECTIONS

CONCEPT DESIGN

0 1 2 4 10 AT **A1**
0 2 4 8 20 AT **A3**

LYMESMITH Polychromy

LOCI

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ISSUED FOR INFORMATION	P2	SC	19/04/2022

CLIENT
PENRITH CITY COUNCIL

PROJECT
KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT

SCALE @ A1	PROJECT NO.	STAGE	DRAWING NO.	REV
NA	21.14	SK	07A	**P2**

SCALE @ A3
NA

DRAWING TITLE
ART. IMPRESSION FROM S.E.

CONCEPT DESIGN

0 1 2 4 10 AT **A1**
0 2 4 8 20 AT **A3**

LYMESMITH Polychromy

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KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT

SCALE @ A1	PROJECT NO.	STAGE	DRAWING NO.	REV
NA	21.14	SK	07B	**P2**

SCALE @ A3
NA

DRAWING TITLE
ART. IMPRESSION FROM S.E.

CONCEPT DESIGN

0 1 2 4 10 AT **A1**
0 2 4 8 20 AT **A3**

LYMESMITH Polychromy

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6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT

SCALE @ A1	PROJECT NO.	STAGE	DRAWING NO.	REV
NA	21.14	SK	08	**P2**

SCALE @ A3
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DRAWING TITLE
ART. IMPRESSION FROM N.E.

Appendix B

Matters of national environmental significance

B1 Consideration of Matters of National Environmental Significance

The table below demonstrates consideration of the matters of national environmental significance (MNES) under the EPBC Act to be considered in order to determine whether the proposal should be referred to the Department of Climate Change, Energy, the Environment and Water.

Table B.1 Consideration of MNES

MNES	Impacts
Any impact on a World Heritage property? There are no World Heritage properties within 1 km of the Proposal.	Nil
Any impact on a National Heritage place? There are no National Heritage places within 1 km of the Proposal	Nil
Any impact on a wetland of international importance? There are no wetlands of international importance within 1 km of the Proposal.	Nil
Any impact on a nationally threatened species or ecological communities? It is unlikely that the development of the Proposal would significantly affect listed threatened species of communities (see Section 6.5).	Nil
Any impacts on listed migratory species? It is unlikely that the development of the Proposal would significantly affect any listed migratory species	Nil
Any impact on Commonwealth marine areas? No impact on Commonwealth marine areas.	Nil
Any impact on the Great Barrier Reef Marine Park? No impact to the Great Barrier Reef Marine Park.	Nil
Does the Proposal involve a nuclear action (including uranium mining?) The Proposal does not involve a nuclear action.	Nil
Any impact on a water resource, in relation to coal seam gas development and large coal mining development? No impact to a water resource in relation to coal seam gas or large coal mine developments.	Nil

Appendix C

Consideration of Clause 228

When considering the likely impact of an activity on the environment, the proponent and determining authority must take into account the factors set out in Table C.1. These are listed in Clause 171(2) of the EP&A Regulation.

Table C.1 Factors to be considered

Environmental Factor		Impact	Level of impact
a	Any environmental impact on a community	There would be some temporary impacts to the community during construction, particularly in relation to noise, traffic, access and visual amenity. The temporary reduction of parking spaces at the existing car park would be an inconvenience to commuters. Mitigation measures outlined in Chapter 7 would be implemented to manage and minimise adverse impacts.	Minor and temporary
b	Any transformation of a locality	The proposal would change the visual environment through construction of the multi-storey commuter car park. The proposal would have a positive contribution to the locality by helping to address the high demand for commuter car parking spaces. The proposal also provides infrastructure that supports potential growth and provides improved public transport facilities.	Minor and permanent
c	Any environmental impact on the ecosystems of the locality	Due to the removal of some planted vegetation at the site, the proposal would have a negligible impact on the local ecosystem. Vegetation removal would be subject to offsetting in accordance with the Transport for NSW Vegetation Offset Guide (Transport for NSW, 2019).	Negligible and permanent
d	Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality	Some short-term impacts during construction would be anticipated, particularly in relation to noise, traffic and access and visual amenity. The visual impacts from the proposal are anticipated to be moderate for adjacent residents during operation. A landscape and visual impact assessment was completed and is summarised in Section 6.2.	Moderate and permanent
e	Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations	The proposal site is not located in close proximity to any registered heritage items. Aboriginal Heritage items are unlikely to be harmed by the proposal. During operation the proposal would have positive impacts to the community through providing a modern car park structure with improved access, lighting and safety measures (such as CCTV). The car park would be consistent with the form and scale of adjacent development and likely future growth.	Negligible and permanent
f	Any impact on the habitat of protected animals (within the meaning of the *Biodiversity Conservation Act 2016*)	The impacts on the habitat of protected fauna is likely to be negligible (see Section 6.5). Vegetation removal would be required to facilitate the proposal and would be subject to offsetting in accordance with the Transport for NSW Vegetation Offset Guide (Transport for NSW, 2019).	Negligible and permanent

Environmental Factor		Impact	Level of impact
g	Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air	The proposal is unlikely to endanger species (see Section 6.5). Vegetation removal would be required to facilitate the development of the Proposal and would be subject to offsetting in accordance with the Transport for NSW Vegetation Offset Guide (Transport for NSW, 2019).	Negligible and permanent
h	Any long-term effects on the environment	The proposal is unlikely to have any long-term effects on the environment.	No impact
i	Any degradation of the quality of the environment	The proposal would result in the minor removal of vegetation. Impacts from the Proposal would be minimised by the implementation of the mitigation measures identified in Chapter 7.	Minor and permanent
j	Any risk to the safety of the environment	Construction of the proposal would be managed in accordance with the mitigation measures outlined in this REF and a CEMP. The proposal is unlikely to cause risks to the safety of the environment provided the recommended mitigation measures are implemented.	Negligible and permanent
k	Any reduction in the range of beneficial uses of the environment	The proposal is unlikely to have any reduction in the range of beneficial uses of the environment.	Nil
l	Any pollution of the environment	The proposal is unlikely to cause any pollution to the environment provided the recommended mitigation measures are implemented.	Minor and permanent
m	Any environmental problems associated with the disposal of waste	The proposal is unlikely to cause any environmental problems associated with the disposal of waste. All waste would be managed and disposed of in accordance with the EPA Waste Classification Guidelines (EPA, 2014). Mitigation measures would be implemented to ensure waste is reduced, reused or recycled where practicable (refer Section 6.11).	Negligible and permanent
n	Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply	The Proposal is unlikely increase demands on resources that are or are likely to become in short supply.	Nil
o	Any cumulative environmental effect with other existing or likely future activities	The cumulative effects of the proposal are described in Section 6.13. Where feasible, environmental management measures would be co-ordinated to reduce any cumulative construction impacts. The proposal is unlikely to have any significant adverse long-term impacts.	Negligible and permanent
p	Any impact on coastal processes and coastal hazards, including those under projected climate change conditions	The proposal is not located in the coastal zone and would not affect or be affected by any coastal processes or hazards.	Nil

Environmental Factor		Impact	Level of impact
q	Any applicable local strategic planning statement, regional strategic plan or district strategic plan made under Division 3.1 of the Act	None relevant to the proposal.	Nil
r	Any other relevant environmental factors	None	Nil

Appendix D

Traffic study

CIVIL ENGINEERING REPORT:
TRAFFIC IMPACT ASSESSMENT REPORT

Kingswood Commuter Carpark

PREPARED FOR
Root Partnerships
Level 19/9 Hunter Street
Sydney NSW 2000

Ref: SY210295-CM04
Rev: 2.2
Date: 06.07.2022

Traffic Impact Assessment Report

Revision Schedule

Date	Revision	Issue	Prepared By	Approved By
18.05.2022	1.0	Draft REF	NG	MP
21.06.2022	1.1	Draft REF	NG	MP
27.06.2022	2.0	REF	NG	MP
28.06.2022	2.1	REF	NG	MP
06.07.2022	2.2	REF	NG	MP

Northrop Consulting Engineers Pty Ltd

ACN 064 775 088 | ABN 81 094 433 100

SAP House, Level 6, 224 Bunda Street (PO Box 213), Canberra ACT 2608

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Table of Contents

1. Introduction

1.1 Background

Northrop Consulting Engineers (NCE) has been engaged by Root Partnerships (RP) to prepare a Traffic Impact Assessment Report on the potential influence of the redevelopment of 6 Cox Avenue, Kingswood.

1.2 Study Objectives

This Traffic Impact Assessment Report is to address the criteria within the approved proposal from NCE to RP SY210295-00 dated 8 February, 2022 and the criteria within the statement SY210295_CM02 as agreed between NCE and RP.

This Traffic Impact Assessment Report will detail the below:

- Parking analysis and traffic analysis in line with the RTA Guide to Traffic Generating Developments (2002) including:
    - A project description;
    - A description of the road network serving development;
    - Determination of the traffic activity associated with the development proposal and its impacts upon the surrounding road network;
    - Confirmation that the proposed carpark, vehicular access and internal circulation arrangements comply with the relevant standards;
    - A description of the proposed service vehicle arrangement;
    - Determination of the traffic generation and trip distribution for the proposed development;
    - Commentary on the proposed development's impact on road safety;
    - Commentary on SIDRA Intersection modelling of the key intersections of;
        - Parker Street and Copeland Street;
        - Copeland Street and Phillip Street;
        - Copeland Street and Richmond Road;
        - Victoria Street and Heath Street; and
        - Cox Avenue and Richmond Road;
    - Commentary on the existing public transport services in the vicinity of the proposed development;
    - Determination of the impact of generated traffic on key adjacent intersections, streets in the neighbourhood of the development and other major traffic generating development sites in close proximity;
    - Commentary on the safety and efficiency of access between the proposed development and the adjacent road network;
    - Commentary around the impact of traffic noise;
    - Determination of the peak period traffic volumes and congestion levels at key adjacent intersections;
    - Commentary on the safety and efficiency of the internal car park and shareway road layout, including service arrangements and parking areas;
    - Identify known existing proposals for improvements to the adjacent road network and hierarchy; and
    - Identification of the AADT – annual average daily traffic – on key adjacent roads.

1.3 Development Locality

The site is located at the corner of Cox Avenue and Richmond Road.

Figure 1 shows the general site within the Kingswood area and Figure 2 shows the site-specific location.

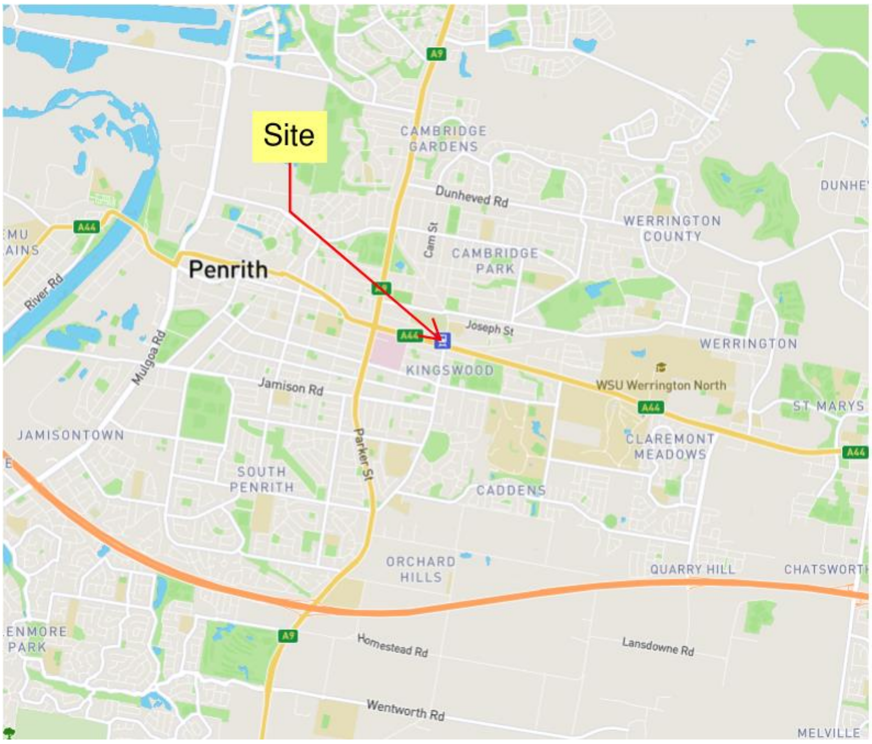


Figure 1 Site Locality (NSW Government Transport for NSW, NSW Road Network Classifications)

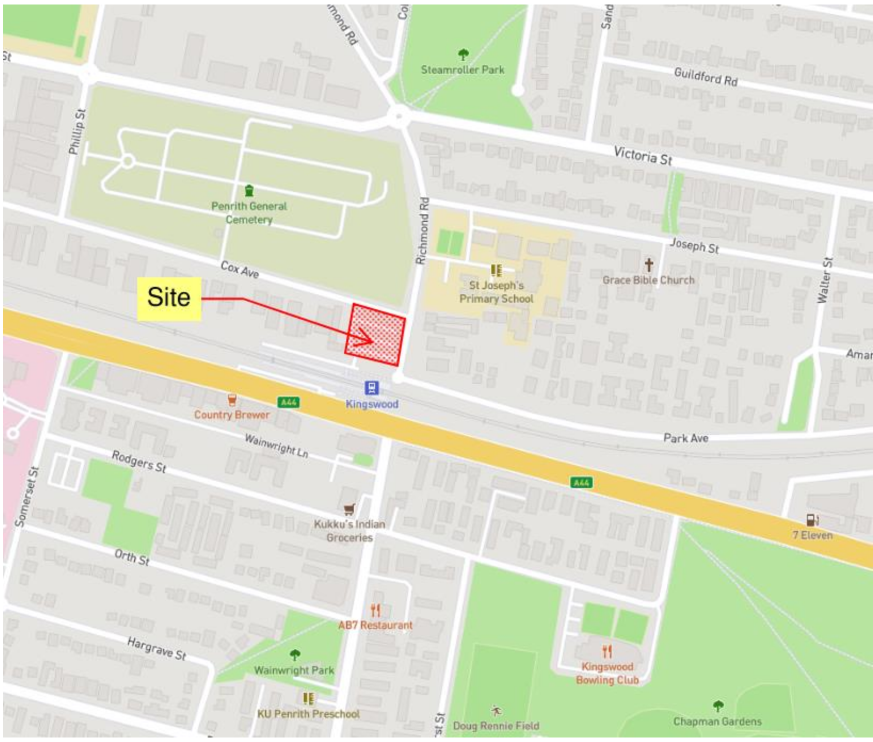


Figure 2 Site Specific Location (NSW Government Transport for NSW, NSW Road Network Classifications)

The site currently contains an at grade carpark and access to the Kingwood Rail Station Northern Carpark (which is further detailed in Section 2 of this report). A site inspection was undertaken by NCE on 25/05/2022 which confirmed the at grade car park is currently in use.

For the purpose of this Traffic Impact Assessment Report, the key roads identified are:

- Richmond Road (between Victoria Street and Park Avenue); and
- Cox Avenue (between Phillip Street and Richmond Road).

These roads have been highlighted in Figure 3.

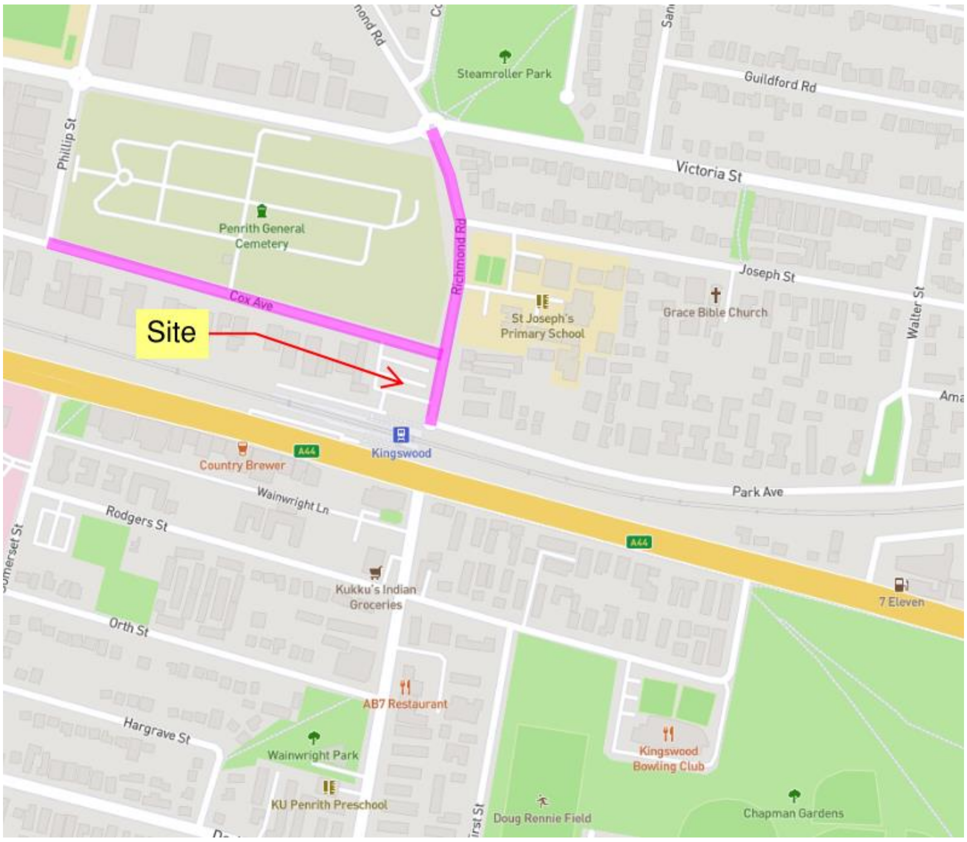


Figure 3 Locality of Key Roads

1.4 Brief Description of the Proposed Development

The redevelopment of the site will involve the construction of a multi-storey carpark containing access to the rail corridor and storage area. The proposed development will have two access driveways; one off Cox Avenue and one off Richmond Road.

1.5 References

In preparing this report, reference has been made to the following:

- AS2890.1:2004 Parking Facilities Part 1: Off-street car parking;
- AS2890.6:2009 Parking Facilities Part 6: Off-street parking for people with disabilities;
- Penrith City Council Penrith DCP 2014;
- RTA Guide to Traffic Generating Developments (2002); and
- Other documents as referenced.

2. Existing Conditions

The following sections detail the existing conditions of the area.

2.1 Site Access

Access to the current at grade carpark is located on both Cox Avenue and Richmond Road.

Access to the Transport for New South Wales (TfNSW) carpark and rail corridor is via this at grade carpark.

Figure 4 illustrates the aforementioned access locations.

Figure 4 Existing Site Access (Mark Up of Metromap Aerial Imagery – 20/09/2021)

2.2 Existing Traffic Conditions

2.2.1 Road Hierarchy

The road hierarchy has been reviewed in accordance with the NSW Government TfNSW NSW Road Network Classifications.

The NSW Road Network Classifications identifies the State Roads, Regional Roads, and Local Roads.

Figure 5 Extract from the NSW Road Network Classifications Map with Marked Up Site Locality

Figure 5 identifies that all roads except the Great Western Highway are Local Roads. The Great Western Highway is classified as a State Road and links Sydney with Bathurst.

2.2.2 Road Conditions, Traffic Management and Parking Control

Observations by NCE were undertaken on 25/05/2022 of the key roads identifying the road conditions, traffic management and parking controls. A summary of road conditions, traffic management and parking controls of the key roads are as follows:

- Richmond Road (between Victoria Street and Park Avenue):
  - Road Conditions:
    - Richmond Road is a two–way, two–lane road with edge line marking (on the Western side only) and double barrier lines;
    - Richmond Road has an approximate carriageway width of 17.5m adjacent to the site; and
    - Richmond Road has a speed limit of 50km/hour except during school zone durations;
  - Traffic Management:
    - Richmond Road meets Victoria Street and Copeland Street at a roundabout;
    - Richmond Road meets Joseph Street and Cox Avenue at T-intersection as the major road;
    - Richmond Road meets Park Avenue at a corner; and
    - Richmond Road has local area traffic management in the form of a gateway indicated by “dragon’s teeth” line marking as well as the school zone speed limit painted onto the road;
  - Parking Control:
    - No Stopping signs are located along Richmond Road near the intersections;

    - There is a signed bus zone adjacent to St Joseph's Primary School on the Eastern side of Richmond Road. The bus zone is operational from 8:00am – 9:30am and 2:30pm – 4:00pm school days; and
    - "No parking" signs are located near the driveway into St Joseph's Primary School on the Eastern Side of Richmond Road.
- Cox Avenue (between Richmond Road and Phillip Street):
  - Road Conditions:
    - Cox Avenue is a two – way two – lane road with a dividing line;
    - Cox Avenue has an approximate carriageway width of 12.5m; and
    - Cox Avenue has a speed limit of 50km/hour except during school zone times;
  - Traffic Management:
    - Cox Avenue meets Richmond Road as the minor road in a give – way configuration. Cox Avenue meets Phillip Street as the major road in a give – way configuration; and
    - Cox Avenue has local area traffic management in the form of a gateway indicated by "dragon's teeth" line marking as well as the school zone speed limit painted onto the road;
  - Parking Control:
    - There are "no stopping" signs near the entry to the cemetery; and
    - There is a bus zone located near the intersection of Cox Avenue and Richmond Road.

2.2.3 Current and Proposed Works

From observations along the key roads on 25/05/2022, no major developments requiring RMS approval were observed to be currently under construction along the key roads.

NCE have not been informed of any current/existing proposals for improvements of the key roads identified for this report.

2.2.4 Parking Supply and Demand

NCE engaged Matrix Traffic and Transport to undertake a Parking Survey close to the area of the car park in line with advice provided by email from Penrith City Council on 21/04/2021 (during the initial traffic engineering engagement for the Kingswood Commuter Carpark works).

The Parking Survey was undertaken on 5 May, 2022 between 6:00am and 10:00am.

The Parking Survey was completed within approximately 400m of the proposed development in line with Figure 6.

Figure 6 Parking Survey Extents

There are a number of parking controls identified through the parking survey. As the development is a commuter car park where it would be anticipated that all day parking would be required, only unrestricted parking areas have been considered further in this report.

2.2.4.1 On-street Parking

Unrestricted on-street parking is available within the area of the parking survey.

It is noted that the capacity of parking available has no correlation across the areas survey. Hence, it has not been further commented on for the purpose of this Traffic Impact Assessment Report.

2.2.4.2 Off-street Parking

For the purpose of this Traffic Impact Assessment Report, the off-street parking refers to the existing TfNSW car parks North and South of the railway and the existing at grade at the location of the site. These have been labelled as A, C and B respectively and are shown in light blue in Figure 6.

The parking survey undertaken indicates that the car parks are not at 100% capacity, however over the 3 car parks, 46 of the 262 available spaces are unoccupied by 10:00am. Of these 46 spaces, 31 are located in the TfNSW car park North of the railway.

The parking survey identified that the peak arrival hour for users of the car parks is between 7:00am to 8:00am.

Over this period, 23.7% of the total number of off-street car parking spaces were occupied.

It is noted that prior to 6:00am, 24.1% of car parking spaces were occupied, however it would be assumed that these spaces have been occupied by vehicles not affecting the general peak hour period for roads, that may have parked overnight or have been arriving to the site over multiple hours prior to 6:00am.

Figure 7 illustrates the total capacity of parking occupied based on the survey by Matrix Traffic and Transport on 5 May, 2022 for each hour starting from 6:00am up until 10:00am in the form of a graph using percentages. It is noted the highest rate of change occurs from 7:00am – 8:00am.

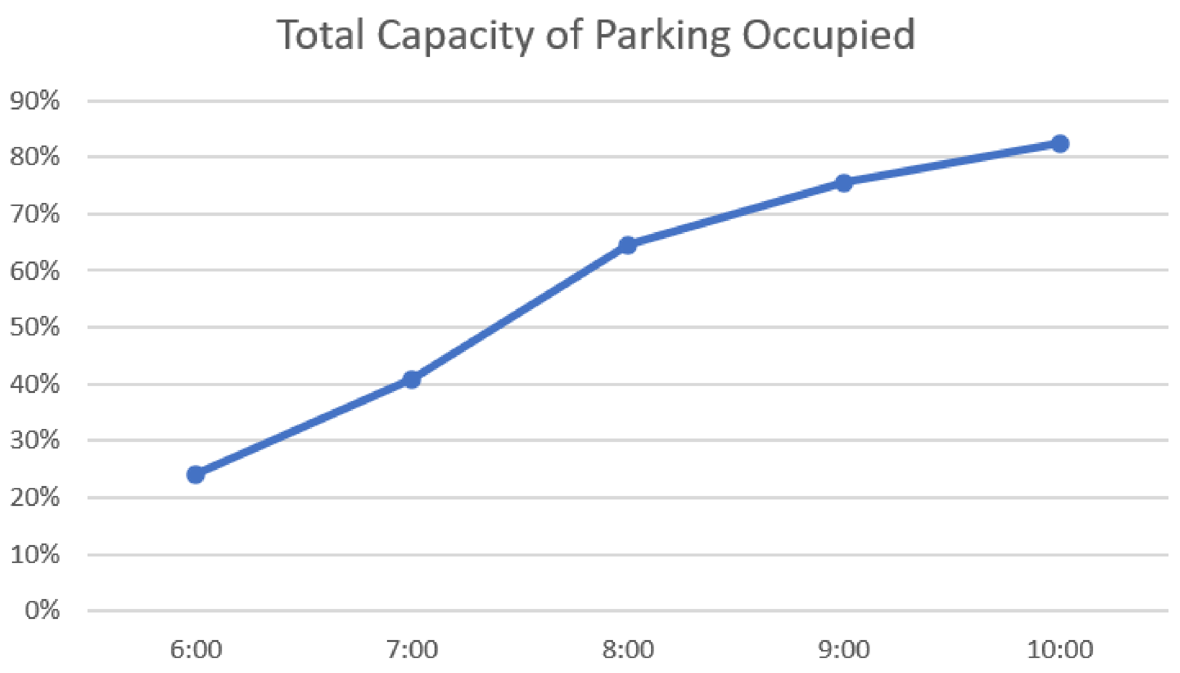


Figure 7 Total Capacity of Parking Occupied Over Car Parks A, B and C

Refer to Appendix C for the detailed parking survey report.

2.2.5 Traffic Flows

2.2.5.1 Key Intersections

For the purpose of this study, the key intersections which commentary has been provided include:

- Parker Street and Copeland Street;
- Copeland Street and Phillip Street;
- Copeland Street and Richmond Road;
- Victoria Street and Heath Street; and
- Cox Avenue and Richmond Road.

These have been identified by Penrith City Council as the intersections for review in line with a meeting between Penrith City Council, RP and NCE on 11/04/2022.

2.2.5.2 Traffic Volumes

Traffic volumes have been captured by Matrix Traffic and Transport through their survey works undertaken for the purpose of this Traffic Impact Assessment Report.

Classified intersection counts have been completed for the key intersections on 5 May, 2022 from 6:00am – 10:00am and from 3:00pm -7:00pm (which have been used for the modelling of key intersections detailed further in this report).

Automatic Traffic Counts have been undertaken from 5 – 11 May, 2022 between the current car park driveway along Richmond Road and Cox Avenue, and the current car park driveway along Cox Avenue and Richmond Road.

A summary of the traffic volumes of the key roads based on the automatic traffic counts are in line with Table 1. It is noted that the averages listed in Table 1 are representative of the AADT.

Table 1 Summary of Traffic Volumes on Key Roads

Road	Direction	Weekday Average Daily Traffic	Weekday Average AM Peak Hour Traffic	Weekday Average PM Peak Hour Traffic
Richmond Road between Current Car Park Driveway and Cox Avenue	North	763	62	69
	South	771	81	67
Cox Avenue between Current Car Park Driveway and Cox Avenue	East	506	39	55
	West	1072	116	83

2.2.5.3 Current Traffic Generation

Based on the survey undertaken by Matrix Traffic and Transport, we understand that the AM peak hour period for the intersection of Cox Avenue and Richmond Road is 7:45am to 8:45am.

It is noted that this correlates with the peak hour for users of the car parks surveyed arriving to the car park is 7:00am to 8:00am.

Hence, it could be assumed that the existing Kingswood commuter car park will generate vehicle movements equal to approximately 23.7% of the total number of car parking spaces during the AM peak period as a conservative estimate for the peak period of 7:45am to 8:45am reviewed.

It is assumed that all movements would be incoming to the car park noting that there is currently a “Kiss and Ride” facility at Kingswood Railway Station to drop off and pick up commuters.

As the existing Kingswood commuter car park has 114 car parking spaces, the total current traffic generation for the site during the AM peak period would be 28 vehicle movements.

Although a car parking survey was not carried out during the PM, we could assume that approximately 23.7% of vehicles leave the car park during the peak times which would be equal to 28 vehicle movements.

2.2.5.4 Daily and Peak Period Heavy Vehicle Flows

The current use of the existing at grade carpark does not indicate that heavy vehicles would need to utilize the site.

However, heavy vehicles may pass through the car park or park in the car park when servicing the existing at grade carpark or Kingswood Rail Station.

2.2.5.5 Traffic Speeds on Key Roads

Traffic speeds have been captured by Matrix Traffic and Transport through their survey works.

The locations of the surveys capturing the traffic speed are approximately as per Figure 8.

Figure 8 Approximate Traffic Speed Survey Locations

A summary of the speed results of the traffic survey are as per Table 2.

Table 2 Traffic Speed Survey Results Summary

Road	Direction	7 Day Average Speed	7 day 85th Percentile Speed	Maximum Speed Range Recorded & Number of Vehicles Recorded at Speed
Cox Avenue	Eastbound	33.3km/hour	38.2km/hour	50-60km/hour & 3 vehicles
	Westbound	34.7km/hour	39.3km/hour	50-60km/hour & 21 vehicles
Richmond Road	Northbound	33.3km/hour	41.0km/hour	70-80km/hour & 1 vehicle
	Southbound	38.4km/hour	45.7km/hour	70-80km/hour & 1 vehicle

From Table 2, the results from the survey undertaken by Matrix Traffic and Transport demonstrate that the 85th percentile speed is less than the posted speed limit of 50km/hour for hours out of school zone hours.

Penrith City Council are to monitor the key roads during operation of the proposed development to determine:

- Whether the speed limit is suitable for the environment when the proposed development is operational; and
- Whether additional infrastructure is required to assist vehicular and pedestrian movements along and across the key roads adjacent the proposed development when the proposed development is operational.

2.2.6 Intersection Performance

The performance of key intersections has been completed using SIDRA Intersection 9 software. Commentaries on the existing performance of the intersections are in the following subsections.

For the purpose of modelling, we have not captured any pedestrians crossing roads for the roundabouts and T intersections modelled and have generally used SIDRA default values.

The results shown include the level of service (LOS), degree of saturation (DOS), delay and 95th percentile queue length.

The LOS is an index of performance of traffic – for these works it refers to the index of performance for the intersection. The LOS is a rating of delay from A – F on the average delay for the intersection or leg of the intersection. The delay for each LOS has been listed in Table 3.

This report contains illustrations of the key intersections modelled showing their respective LOS for each lane based on delay. Each LOS has been colour coded as per the following:

- LOS A – Green;
- LOS B – Light Blue;
- LOS C – Dark Blue;
- LOS D – Purple;
- LOS E – Orange; and
- LOS F – Red.

Table 3 Level of Service in Terms of Delay

LOS	Average Delay (d) in seconds
A	d < 14
B	d < 15 to 28
C	d < 29 to 42
D	d < 43 to 56
E	d < 57 to 70
F	d > 70

The DOS is the ratio of arrival flow rate to capacity during a given flow period.

Delay is the additional travel time experienced by a vehicle relative to a base time.

A queue refers to a line of vehicles waiting to proceed through a point of interruption.

The AM peak period has been taken as 7:45am – 8:45am and the PM peak period has been taken as 4:45pm – 5:45pm. These peak periods are assumed for the development noting they represent the peak periods of the key intersection of Richmond Road and Cox Avenue.

2.2.6.1 Parker Street and Copeland Street

The intersection of Parker Street Copeland Street has been modelled using SIDRA Intersection 9 for the current conditions.

Due to onsite observations, Northrop has changed the traffic light sequence from the SCATS graphic provided by TfNSW to a sequence which more closely aligns to that observed from video footage for 05/05/2022 provided by Matrix Traffic and Transport.

Figure 9 illustrates the LOS for the AM and PM peak periods for the intersection of Parker Street and Copeland Street.

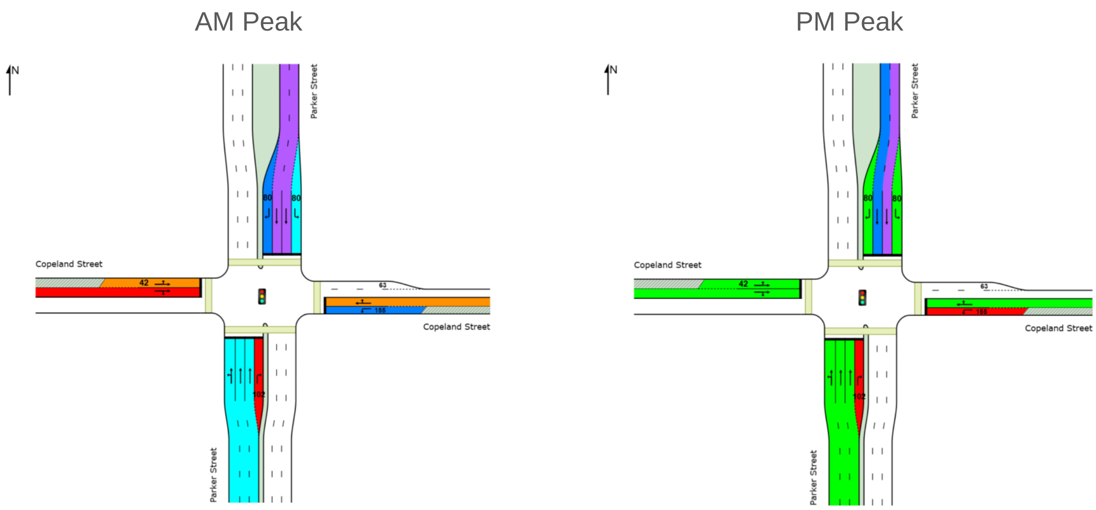


Figure 9 LOS Summary for Parker Street and Copeland Street Existing Conditions

A summary of the results is available in Table 4.

Table 4 SIDRA Intersection Results for the Intersection of Parker Street and Copeland Street Existing Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Parker Street North	AM	D	0.905	47.2	400
Copeland Street West	AM	F	0.870	71.0	54
Parker Street South	AM	C	0.886	31.0	205
Copeland Street East	AM	C	0.652	42.1	190
Parker Street North	PM	D	0.915	56.4	406
Copeland Street West	PM	E	0.473	65.6	51
Parker Street South	PM	D	0.912	25.1	191
Copeland Street East	PM	B	0.924	48.2	163

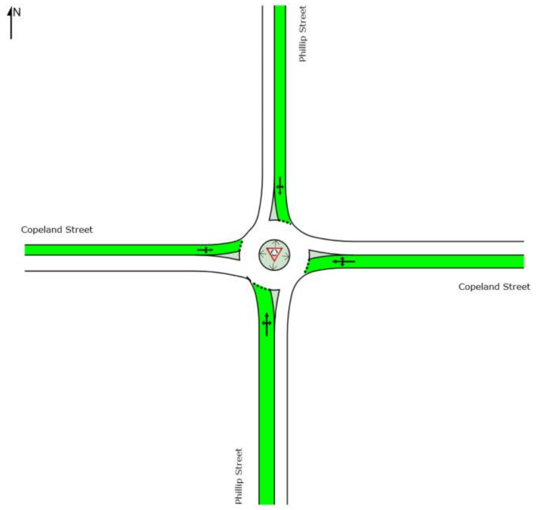
From the results in Table 4 associated with the intersection summary, it is noted that the intersection as a whole in both the AM and PM peak is considered to be satisfactory in line with the RTA Guide to Traffic Generating Developments (2002). In line with Table 4 however, it is noted that particular legs of the intersection have a LOS of F.

2.2.6.2 Copeland Street and Phillip Street

The intersection of Copeland Street and Phillip Street has been modelled using SIDRA Intersection 9 for the current conditions.

Figure 10 illustrates the LOS for the AM and PM peak periods for the intersection of Copeland Street and Phillip Street.

AM Peak



PM Peak

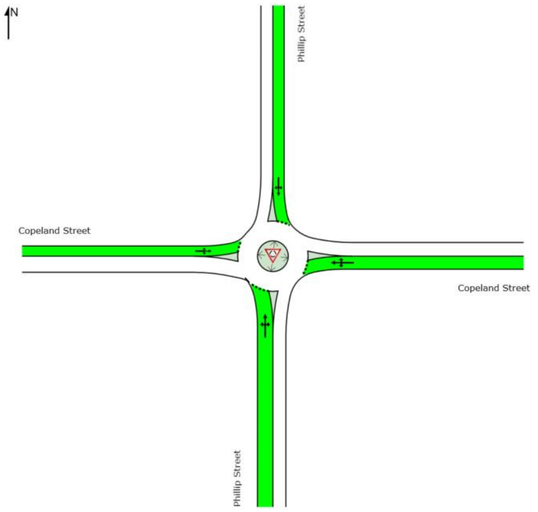


Figure 10 LOS Summary for Copeland Street and Phillip Street Existing Conditions

A summary of the results is available in Table 5.

Table 5 SIDRA Intersection Results for the Intersection of Copeland Street and Phillip Street Existing Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Phillip Street North	AM	A	0.188	8.2	5
Copeland Street West		A	0.366	4.7	20
Phillip Street South		A	0.071	8.6	3
Copeland Street East		A	0.597	5.9	40
Phillip Street North	PM	A	0.049	9.9	2
Copeland Street West		A	0.377	4.0	22
Phillip Street South		A	0.098	8.0	3
Copeland Street East		A	0.475	4.1	30

From the results in Table 5, it can be seen that the intersection currently has free flowing conditions with minimal delays or queuing for both the AM and PM peak periods.

2.2.6.3 Copeland Street and Richmond Road

The intersection of Copeland Street and Richmond Road has been modelled using SIDRA Intersection 9 for the current conditions.

Figure 11 illustrates the LOS for the AM and PM peak periods for the intersection of Copeland Street and Phillip Street.

AM Peak PM Peak

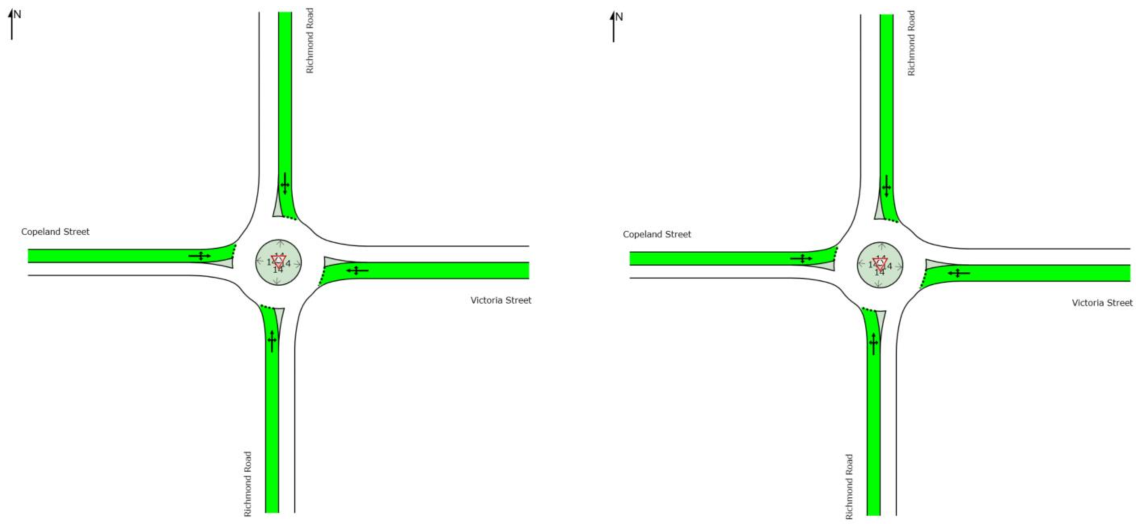


Figure 11 LOS Summary for Copeland Street and Richmond Road Existing Conditions

A summary of the results is available in Table 6.

Table 6 SIDRA Intersection Results for the Intersection of Copeland Street and Richmond Road Existing Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Richmond Road North	AM	A	0.355	7.0	16
Copeland Street		A	0.281	5.6	13
Richmond Road South		A	0.295	9.8	26
Victoria Street		A	0.538	6.2	12
Richmond Road North	PM	A	0.273	7.7	12
Copeland Street		A	0.477	5.8	25
Richmond Road South		A	0.265	9.7	11
Victoria Street		A	0.588	5.8	30

From the results in Table 6, it can be seen that the intersection currently has free flowing conditions with minimal delays or queuing for both the AM and PM peak periods.

2.2.6.4 Victoria Street and Heath Street

The intersection of Victoria Street and Heath Street has been modelled using SIDRA Intersection 9 for the current conditions.

Figure 12 illustrates the LOS for the AM and PM peak periods for the intersection of Victoria Street.

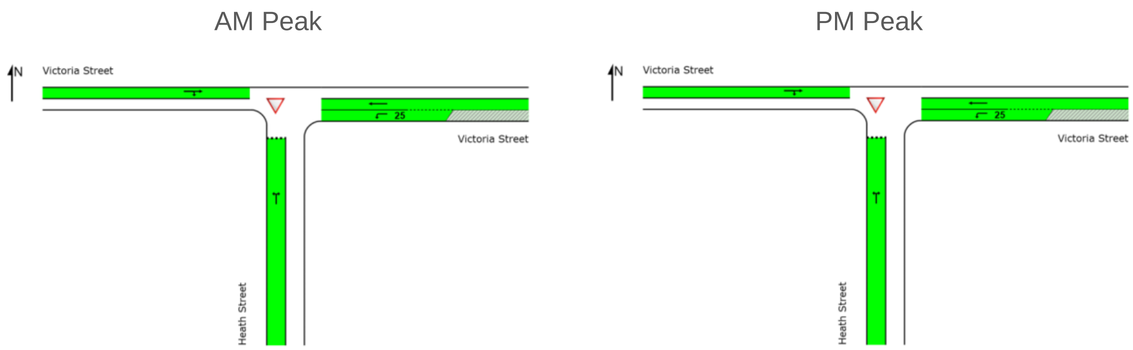


Figure 12 LOS Summary for Victoria Street and Heath Street Existing Conditions

A summary of the results is available in Table 7.

Table 7 SIDRA Intersection Results for the Intersection of Victoria Street and Heath Street Existing Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Victoria Street East		N/A	0.180	0.5	0
Victoria Street West	AM	N/A	0.147	0.5	1
Heath Street		A	0.039	8.8	1
Victoria Street East		N/A	0.278	0.5	0
Victoria Street West	PM	N/A	0.159	0.2	0
Heath Street		A	0.058	11.4	1

From the results in Table 7, it can be seen that the intersection currently has free flowing conditions with minimal delays or queuing for both the AM and PM peak periods.

2.2.6.5 Cox Avenue and Richmond Road

The intersection of Cox Avenue and Richmond Road has been modelled using SIDRA Intersection 9 for the current conditions.

Figure 13 illustrates the LOS for the AM and PM peak periods for the intersection of Victoria Street.

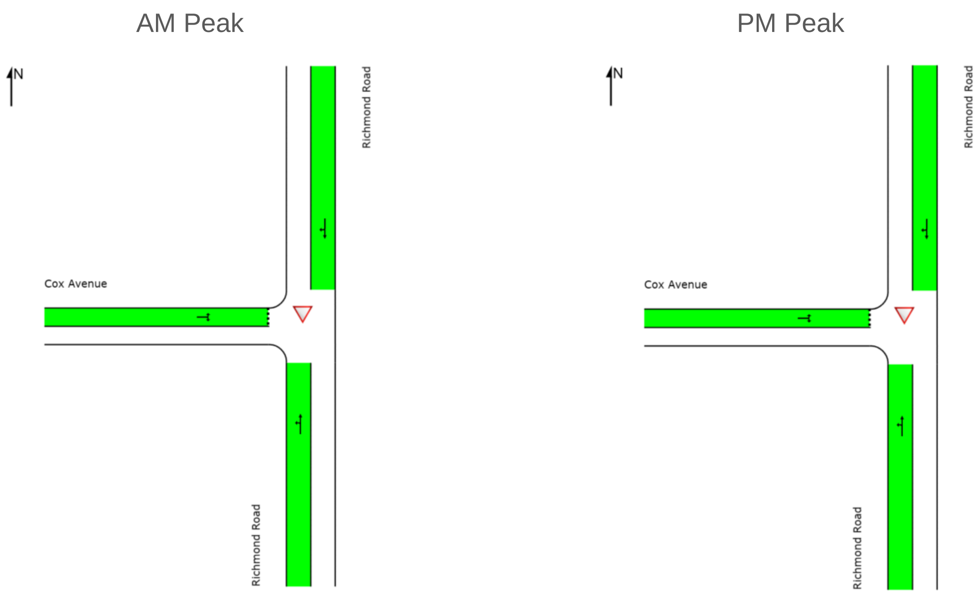


Figure 13 LOS Summary for Cox Avenue and Richmond Road Existing Conditions

A summary of the results is available in Table 8.

Table 8 SIDRA Intersection Results for the Intersection of Cox Avenue and Richmond Road Existing Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Richmond Road North	AM	N/A	0.078	2.7	3
Richmond Road South		N/A	0.031	1.8	0
Cox Avenue		A	0.023	4.9	1
Richmond Road North	PM	N/A	0.064	2.4	2
Richmond Road South		N/A	0.041	1.1	0
Cox Avenue		A	0.033	4.9	1

From the results in Table 8, it can be seen that the intersection currently has free flowing conditions with minimal delays or queuing for both the AM and PM peak periods.

2.2.7 Traffic Safety

2.2.7.1 Accident History within the area

Existing accident data was obtained from the NSW Government Transport for NSW Centre for Road Safety Website (accessed 19/05/2022).

The accident data available for the Local Government Area of Penrith was for 2016 – 2020. An extract of the Kingswood Commuter car park site-specific area is as per Figure 14.

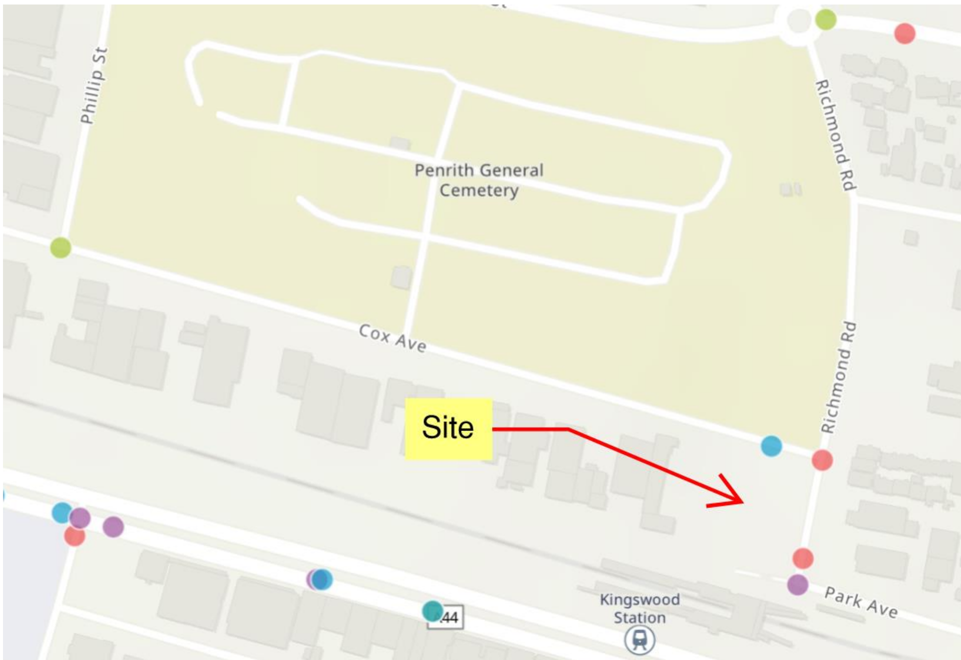


Figure 14 Accident Data (Extract from the NSW Government Transport for NSW Crashes Map)

Figure 14 shows 5 accidents along the key roads of Cox Avenue and Richmond Road as described in section 1.3 of this Traffic Impact Assessment Report.

The blue dot in Figure 14 represents a vehicular crash from a vehicle emerging from a driveway resulting in a moderate injury.

The green dot in Figure 14 represents a vehicular crash from vehicles travelling from adjacent directions at the intersection of Phillip Street and Cox Avenue resulting in serious injury.

The red dot at the intersection of Cox Avenue and Richmond Road in Figure 14 represents a vehicular crash from to vehicles travelling from opposing directions at the intersection resulting in a non-casualty (towaway).

The red dot along Richmond Road in Figure 14 represents a vehicular crash from a parked vehicle running into another object resulting in a non-casualty (towaway).

The purple dot at the intersection of Park Avenue and Richmond Road in Figure 14 represents a pedestrian and vehicular crash with a pedestrian on the road in a minor/other injury.

It is noted there are only 5 incidents along the key roads within the 5 reporting years. The accidents do not follow a trend.

The key roads also do not meet the requirements to be a black spot in line with the requirements listed by The Department of Infrastructure, Transport, Regional Development and Communications.

The available accident data does not represent any ongoing issues to be addressed through the development of the Kingswood Commuter Carpark, however Penrith City Council are to monitor the area and address safety concerns should they arise.

2.2.8 Public Transport and Pedestrian Infrastructure

2.2.8.1 Rail Station Location and Services

The site is located adjacent the Kingswood Rail Station serviced by TfNSW.

Figure 15 illustrates the location of the site in proximity to the Rail Stations.

Figure 15 Location of Site in Proximity to Kingswood Rail Station (Extract from Metromap)

Kingswood Rail Station has the following train route service it:

- T1 Line which provides services between Berowra, Hornsby, Gordon, Chatswood, Central, Lidcombe, Parramatta, Richmond and Emu Plains.

The T1 line provides connectivity to:

- The Sydney Rail Network;
- The Intercity Trains Network; and
- Locations and other transport modes through the greater network.

2.2.8.2 Bus Stop Locations and Services

There are five bus stops in close proximity to the site inclusive of:

- St Joseph's Primary School Richmond Road;
- Park Ave opp Kingswood Station;
- Kingswood Station;
- Kingswood Station, Great Western Highway; and
- Great Western Highway opp Kingswood Station.

Routes which service these bus stops include:

- N70 Penrith to City Town Hall (Night Service) which services between Penrith, Blacktown. Parramatta, Central Station and Town Hall Station;
- N70 City Town Hall to Penrith (Night Service) which services between Town Hall Station, Central Station, Parramatta, Blacktown and Penrith;
- 4000 Afford Minchinbury to Cherrywood Village which services between Minchinbury, Penrith and Llandilo;
- 4000 Cherrywood Village to Afford Minchinbury which services between Llandilo, Penrith and Minchinbury;
- 4113 Kingswood Station to Kingswood PS which services between Kingswood Station (South side) and Kingswood Public School; and
- 4149 Park Av after Richmond Rd to Kingswood Station which services between Kingswood Station (North side) to St Joseph's Primary School Richmond Road.

2.2.8.3 Pedestrian Infrastructure

From observations undertaken by NCE on 25/05/2022, it was observed there is a footpath along the Eastern side of Richmond Road linking the existing at grade carpark with Kingswood Station bus stop and Kingswood Rail Station.

Pedestrians were also observed to traverse through the TfNSW car park to get to the existing at grade carpark.

3. Proposed Development

3.1 Development Description

The development is a multistorey car park with a storage area.

There is a lower ground floor with access of Richmond Road which contains:

- 57 car parking spaces;
- A route through to the existing TfNSW car park;
- Bicycle parking;
- Motorcycle parking;
- TfNSW waste storage; and
- Ancillary areas associated with the development.

The remaining carpark has access off Cox Avenue. The access leads to the ground floor which has access to 3 above floors. The ground floor and 3 above floors contain 364 car parking spaces.

The development works will create a shareway between the proposed Kingswood Commuter Carpark and the existing Kingswood Rail Station. This shareway has been nominally detailed as a shared zone in line with relevant Australian Standards. The shareway also contains a loading zone for service vehicles to utilise when servicing the proposed Kingswood Commuter Carpark and the existing Kingswood Rail Station. Penrith City Council and TfNSW are to advise if the loading zone is suitable in size and position prior to the completion of the detailed design phase of the works. Refer to drawing 210295_C190 Rev 3 in Appendix D for nominal set out of the loading zone.

3.2 Access

3.2.1 Driveway

Driveway access to the proposed development is off Richmond Road for the Lower Ground Floor of the development (which also provides access to the existing TfNSW car park).

Driveway access to the proposed development is off Cox Avenue for the Ground Floor of the development and Levels 1 – 3 of the development.

Refer to Section 3.3 in regards to the compliance of the driveways to the applicable standards and development control plan.

3.2.2 Service Vehicle Access

NCE has been informed by RP that there will be a 9.7m service vehicle which traverses through the Lower Ground Floor of the proposed development to the shareway and back out to Richmond Road in line with Figure 16. Refer to architectural drawing ‘project number 21.14, stage CD, drawing number A120, rev P5 dated 24/06/2022’ by Sam Crawford Architects for the locality of the shareway in relation to the proposed development. The vehicle passage has allowed for a 500mm offset from the vehicle in line with the Penrith City Council Penrith DCP 2014.

The 500mm offset from the vehicle as shown by the dashed line in Figure 16 exceeds the requirements of AS2890.2:2018 Parking facilities Part 2: Off-street commercial vehicle facilities. The path of travel for the service vehicle also meets the requirements in relation to height for the design vehicle (assumed to be the Penrith City Council 9.7m heavy rigid waste collection vehicle in line with the Penrith City Council Penrith DCP 2014).

The floor to ceiling height is a minimum of 3.5m through the service vehicle route through the proposed development. Penrith City Council and TfNSW will be required to confirm if this is satisfactory for all vehicles that will need to move through the development during its operation and confirm this with the design team.

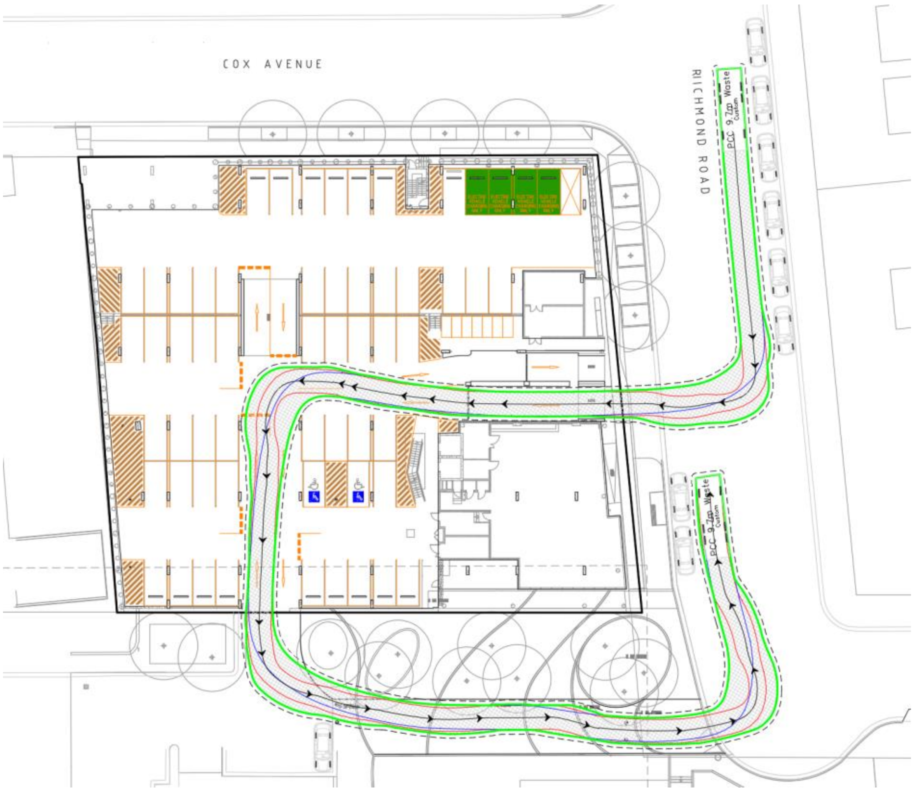


Figure 16 9.7m Service Vehicle Traversing through the Proposed Development and out via the Shareway

The shareway has been designed for a 12.5m vehicle to enter and exit it. TfNSW are to confirm this is appropriate for their operations prior to finalization of the design of the shareway. Refer to the drawings 210295_C035 Rev 3 and 210295_C036 Rev 3 in Appendix D.

3.3 Compliance to Relevant Standards

As part of this Traffic Impact Assessment Report, RP have informed NCE:

- The parking is User Class 1 for the ground floor and Levels 1 – 3 (AS2890.1 Table 1.1); and
- The parking is User Class 3A for the lower ground floor (AS2890.1 Table 1.1).

NCE has completed the carpark design compliance review using the following drawings by Sam Crawford Architects (SCA):

- Project Number 21.14 Stage CD Drawing No. A120 Rev P5 dated 24/06/2022;
- Project Number 21.14 Stage CD Drawing No. A121 Rev P4 dated 24/06/2022;
- Project Number 21.14 Stage CD Drawing No. A122 Rev P4 dated 24/06/2022;
- Project Number 21.14 Stage CD Drawing No. A123 Rev P4 dated 24/06/2022;
- Project Number 21.14 Stage CD Drawing No. A300 Rev P5 dated 24/04/2022; and
- Project Number 21.14 Stage CD Drawing No. A301 Rev P4 dated 24/06/2022.

Through compliance of Australian Standards and Penrith City Council Development Control Plan 2014, safety and efficiency of the internal car park, driveways and shareway road including service arrangements and parking areas are addressed. The safety and efficiency have also been enhanced through drawings 210295_C190 Rev 3, 210295_C191 Rev 3, 210295_C192 Rev 2 and 210295_C193 Rev 2. The safety and efficiency of the internal car park, driveways and shareway road are to be reviewed through the remainder of the design phase of the works, the construction phase and operation of the proposed development including at safety in design meetings.

The following sections go through the review of the documents.

3.3.1 AS2890.1:2004 Parking Facilities Part 1: Off-street car parking

1. The car parks have been designed to be compliant to User class 3A for the lower ground floor and User class 1 for the remaining floors. (Table 1.1)
2. The lower ground floor has parking spaces with length of 5.4m and width of 2.7m (except for the accessible and shared spaces). The aisle widths on the lower ground floor are at least 6.2m at the lower ground floor. (Figure 2,2)
3. All floors other than the lower ground floor have parking spaces with length of 5.4m and width of 2.4m. All floors other than the lower ground floor have aisle widths of at least 6.2m. (Figure 2.2)
4. Where parking modules are next to a wall or fence, or there is an obstruction for door opening, parking modules generally have an additional 300mm space to the wall, fence or obstruction. This is to be monitored over the detailed design phase of the works to ensure AS2890.1 is adhered to (Clause 2.4.1.b.ii)
5. Northrop has found general compliance for the car park in relation to blind aisles. The architect is to ensure that there is room for a 1m aisle extension when the aisle is less than 6 car parking spaces in length. (Clause 2.4.2.c)
6. Physical controls for the car parking spaces will need to be considered. It is assumed physical controls for car parking will be covered as part of the detailed design stage by the project team. (Clause 2.4.5)
7. As part of the detailed design phase, the design team will ensure the maximum and minimum gradients will be in accordance with AS2890.1:2004. (Clause 2.4.6)
8. A provisional area has been set aside for motorcycle parking spaces. The individual motorcycle parking spaces have been specified on plan 210295 C190 Rev 3. (Clause 2.4.7)
9. One – way roadways will require to be at least 3.0m between kerbs (plus at least a 300mm offset from structures). This will need to be finalised during the detailed design phase by the project team. (Cl 2.5.2.a.i)
10. Two – way roadways will require to be at least 5.5m between kerbs (plus at least a 300mm offset from structures). This has been achieved and will need to be maintained during the detailed design phase by the project team. (Cl 2.5.2.a.ii)
11. Double roadways separated by a median will require a median with width of 600mm. This will need to be finalised during the detailed design phase by the project team. (Cl 2.5.2.a.iii)
12. Autoturn software has been used to demonstrate that a B99 can pass a B85 through an intersection. (Cl 2.5.2.c)
13. Ramp grades have been documented with the intent of AS2890.1 however should be considered to be documented to allow for tolerances during construction. (Cl 2.5.3)
14. The entry and exit driveways to Cox Avenue are to be at least 1m apart. (Cl 3.2.1)
15. The entry and exit driveways to Cox Avenue are between 6m and 9m in width each. (Table 3.2)
16. The driveway to Richmond Road is between 6m and 9m in width each. (Table 3.2)
17. Driveways to the car park are more than 6m to the tangent point of the intersection of Cox Avenue and Richmond Road. (Figure 3.1)

18. Sight distances will need to be maintained during the detailed design phase of the works. (Cl 3.2.4)
19. The gradients into the block will need to be developed by the project team during the detailed design phase of the works to meet the requirements of the Australian Standards. (Cl 3.3)
20. Queuing has been reviewed in line with Austroads Guide to Traffic Management Part 2 (April 2020) in lieu of AS2890.1:2004. NCE have been informed that boom gates will not be installed immediately, however provision has been allowed for future installation of them.

    For the lower ground, noting there is room for 2 vehicles to queue within the block, 57 car parking spaces associated with the Kingwood Commuter Carpark and 77 car parking spaces associated with the existing TfNSW car park and assuming the chosen control point/boom gate can service 300 vehicles per hour, there would be less than 9% chance of the queue extending beyond the block boundary assuming all car parking spaces are taken within a 1 hour period.

    For the remaining floors with 364 car parking spaces, noting there are 2 control points in the form of boom gates which allow queuing for 3 vehicles each, assuming vehicles would queue evenly across both entries and each boom gate can service 300 vehicles per hour, there would be approximately a 3% change of the queue extending beyond the block boundary.
21. Pedestrian entries and exits to the car park are separate to vehicular entry and exits. A desired path of travel has been provided through the car park for pedestrians. (Cl 4.1.1)
22. The access consultant will be required to comment on pedestrian access and egress in line with relevant building codes and standards. (Cl 4.1.2)
23. Signposting through the car park related to vehicle movements has been preliminarily developed for the purpose of the 50% detailed design submission – refer to plans 210295_C190 Rev 3, 210295_C191 Rev 3, 210295_C192 Rev 2 and 210295_C193 Rev 2. These plans will need to be developed prior to construction. (Cl 4.3)
24. Pavement markings through the car park related to vehicle movements have been preliminarily developed for the purpose of the 50% detailed design submission – refer to plans 210295_C190 Rev 3, 210295_C191 Rev 3, 210295_C192 Rev 2 and 210295_C193 Rev 2. These plans will need to be developed prior to construction. (Cl 4.4)
25. The electrical engineer will need to ensure lighting is compliant to the relevant Australian Standards and local standards, codes and guidelines. (Cl. 4.7)
26. The architect will need to ensure throughout the design and construction phases that sight distances are maintained. Penrith City Council will need to ensure during the operational and demolition phases of the works that sight distances are maintained at entries and exits to the development. (Cl 4.8)
27. Columns have not been positioned in the design envelopes around vehicle parking spaces. (Cl 5.2)
28. Headroom across the car park is currently noted to be at least 2.2m for general passenger vehicles. This will need to be maintained throughout the design process and the design life of the car park. It is assumed that where other height clearances will be met as needed for particular vehicles. (Cl 5.3.1)

3.3.2 AS2890.2:2018 Parking Facilities Part 2: Off-street commercial vehicle facilities

1. Circulation roads have been modelled using the design vehicle as advised by RP. (Table 3.1 Note 3)
2. Grades do not exceed 15.4% for commercial vehicles. (Table 3.2)
3. Considering Richmond Road to be a minor road, the waste vehicle is able to enter and leave the access driveways without infringing the boundaries of the road. (Cl 3.4.1.a)
4. The entry and exit for the waste vehicle have been developed through swept path movements in lieu of the 10.0m wide entry required. (Figure 3.2)

5. The driveway grade must not exceed 5% for the first 6m into the block. This will need to be addressed as part of the detailed design phase of the works. (Cl 3.4.4)
6. Sight distances will need to be reviewed as part of the detailed design process. (Figure 3.3 and Figure 3.4)
7. The design has allowed space for 1 drive through loading area for vehicles of 9.7m in length or less. Loading/unloading is to occur from the ground level. (Cl 4.1)
8. The loading area will be at most 4% measured in any direction. The width of the loading area is to be at least 3.5m and the length of the loading area is to be at least 12.5m long. This will need to be addressed by the civil engineer at the detailed design phase. The civil engineer must also incorporate any other requirement for the loading dock area as required by authorities or services using the area. (Cl 4.2)
9. The design vehicle is able to manoeuvre into and dock with its service bay without the vehicle infringing the boundary of the service area. (CL4.3.1.a)
10. Swept paths have been undertaken showing the design vehicle can move into and out of the development along the desired path with the offsets required by the Penrith City Council Penrith Development Control Plan 2014. (Cl 5.1)

3.3.3 AS2890.3:2015 Parking Facilities Part 3:2015

1. It is noted that the bicycle parking allowance includes for 1 security level A space and 14 security level C spaces.
2. The security level C bicycle parking spaces are positioned over a 1m envelope in line with the standard. (Figure 2.2)
3. The architect is to ensure that the security level A bicycle parking space is suited to the locker specified and meets the requirements of the standard as part of the detailed design phase. (Cl 2.2.2)
4. The architect is to ensure that the aisle in the bicycle parking room is at least 2m for the security level A bicycle parking and 1.5m for the security level C bicycle parking. This will need to be addressed in the detailed design phase of the works. (Table 2.1)
5. It is assumed that the bicycle parking area will be appropriately design for lighting by a suitably qualified electrical engineer. (Cl 2.8)
6. Bicycle parking facilities should be constructed from materials which will minimise the need for maintenance and retain an acceptable appearance. It is assumed this will be addressed by the project team. (Cl 2.10)
7. Bicycle parking devices specified are to be in line with section 3 of AS2890.3:2015. It is assumed this will be addressed by the project team. (Section 3)

3.3.4 AS2890.6:2009 Parking Facilities Part 6: Off-street parking for people with disabilities

1. Dedicated (non-shared) car parking spaces are at least 2.4m wide and 5.4m long. (Cl 2.2.1.a.i)
2. Shared areas are on at least one side of each dedicated (non-shared) car parking spaces with dimensions of at least 2.4m in width and 5.4m in length. (Cl 2.2.1.b.i)
3. There is a shared space 2.4m long and 2.4m wide at one end of the dedicated spaces. (Cl 2.2.1.c).
4. The shared areas are at the same level as the dedicated spaces. (Cl 2.2.1.d)
5. Bollards have been specified in the shared spaces as part of the design drawings in accordance with the standard. (Cl 2.2.1.e)
6. The dedicated and shared spaces are 90 degree parking. (Cl 2.2.1.f)
7. The maximum grade of the dedicated car parking and shared spaces is 2.5% in any direction. The dedicated car parking and shared spaces are to have a slip – resistant surface. The project team will need to address this in the detailed design phase of the works. (Cl 2.3)
8. The headroom above the dedicated car spaces and adjacent shared spaces is to be 2.5m. Across the remainder of the car park, the headroom must be at least 2.2m. This is to be

addressed by the project team through the detailed design phase of the works. It has been assumed that this standard supersedes the requirements of AS2890.1. (Cl 2.4)

9. Dedicated and shared spaces are to have identification and delineation in line with the standard. The project team will need to ensure compliance to this as part of the detailed design phase. (Section 3)

3.3.5 Penrith City Council Development Penrith Control Plan 2014 Part C10

1. Parking provided on site is in line with AS2890.1. It has been noted that disabled parking has been designed and provided in accordance with AS2890.6. (Cl 10.5.1.C.a)
2. Carparking has been specified by Penrith City Council in lieu of using rates from the development control plan. The minimum number of 410 car parking spaces has been met as specified by the scope of the works. (Cl 10.5.1.C.b)
3. Waste collection for the proposed development and Kingwood Rail Station has been allowed for. It is assumed that should the development require deliveries; it will be able to be serviced by the loading area (note maximum vehicles length allowed for the development will be the design vehicle with length of 9.7m). TfNSW will need to confirm that the loading area will be able to accommodate vehicles which provide services to them. This will need to be confirmed during the detailed design phase. (Cl 10.5.1.C.g)
4. The floor-to-floor height is currently 2.8m. Penrith City Council are to confirm if the floor to ceiling height is to be 2.8m prior to the completion of the detailed design phase of the works. (Cl 10.5.1.C.j)
5. It has been assumed that others will ensure compliance for ventilation of the car park in line with the requirements of Penrith City Council. (Cl 10.5.1.C.l)
6. Movement of pedestrians throughout the car park must be clearly delineated and be visible for all users of the car park to minimise conflict with vehicles. It is assumed that this will be addressed by others as part of the detailed design phase. (Cl 10.5.5.b)
7. Car parking areas will be concrete with parking bays line marked. (Cl 10.5.5.d)
8. The civil engineer will be designing the stormwater system and runoff in line with relevant standards, codes and guidelines. (Cl 10.5.5.f)
9. The car park will have a screen to assist with visual separation. This element of design is being undertaken by others. (Cl 10.5.5.h)
10. All vehicles will be able to enter and leave the car park in a forward direction. (Cl 10.5.5.i)
11. Directional signage has been designed to preliminary stage. This will need to be further developed in line with advice from Penrith City Council during the detailed design stage of the works. (Cl 10.5.5.j)
12. It is assumed that passive surveillance will be managed by others if required. (Cl 10.5.5.l)
13. Vehicular ramps have been detailed on Sam Crawford Architects plans to meet the intent of the Australian Standards. (Cl 10.5.5.q)
14. The project team has proposed a loading area within the shareway. This has been positively received from both Penrith City Council and TfNSW. (Cl 10.5.5.s)
15. The project team has proposed a loading area which will accommodate waste collection. This has been positively received from both Penrith City Council and TfNSW. (Cl 10.5.5.t.ii)
16. The loading area has been planned to cater for the design vehicle as nominated by RP for its circulation and access in line with the intent of AS2890.2:2018. The civil engineer is to ensure full compliance to AS2890.2:2018 is achieved in the loading zone area. (Cl 10.5.5.t.v)
17. The project team is to ensure that the multi-deck car park incorporates communication devices such as intercoms at boom gates, public address systems, telephones or emergency alarms. This is assumed to be undertaken during the detailed design phase of the works. (Cl 10.5.5.v)
18. Security intercoms and appropriate signage will be required in the car park to locate the exit and access locations. This will need to be addressed by the project team as part of the detailed design phase. (Cl 10.5.5.w)

19. The surface carpark should be painted in a light coloured paint or finished in light grey concrete to reflect as much light as possible. This will need to be addressed by the architect as part of the detailed design phase. (Cl 10.5.5.x)
20. The car park has been designed to cater for a 9.7m long vehicle as nominated by Penrith City Council. (Cl 10.5.5.aa)
21. SIDRA Intersection modelling will be used to determine if the surrounding intersections have capacity to absorb the generated traffic from the development. (Cl 10.5.2.B.c)

3.4 Parking

3.4.1 Car Parking

The required number of car parking spaces for the proposed development has been derived by a brief provided by RP.

The total required car parking spaces is 410.

The development currently provides 421 car parking spaces.

3.4.2 Motorcycle Parking

The Penrith City Council Development Control Plan 2014 has been reviewed for requirements for motorcycle parking.

As the development control parking remains silent on the issue, it is assumed that there is no minimum requirement.

The proposed development has however allowed for an area for motorcycle parking. Based on the dimensions of the area, there would be an allowance for at least 7 motorcycle parking spaces.

3.4.3 Bicycle Parking

The Penrith City Council Development Control Plan 2014, Part C10 Transport Access and Parking indicates that bicycle parking should be in accordance with the suggested bicycle parking provision rates listed in the document ‘Planning Guidelines for Walking and Cycling’ (NSW Government 2004).

The ‘Planning Guidelines for Walking and Cycling’ does not list rates for bicycle parking for storage areas or car parks.

However, bicycle parking has been included as part of the development.

4. Impact of Proposed Development

4.1 Traffic Generation

The proposed traffic generation has been based on the current traffic generation of the site in line with Section 2.2.5.2 of this report.

This would assume on a weekend that 23.7% of car parking spaces available to the public would generate an incoming vehicle movement to the development in the weekday AM peak period and an outgoing vehicle movement in the weekday PM peak period.

As this is a commuter car park, it would be assumed the development would not generate as many vehicle movements on a typical general weekend.

Noting there is only a storage space noted, it would be assumed the whole car park will be available for commuter car parking purposes.

The traffic generation for the proposed development is as per Table 9.

Table 9 Traffic Generation

Day	Time	Generation Rate	Number of Car Parking Spaces	Generated Trips
Weekday	AM Peak	23.7%	421	100
Weekday	PM Peak	23.7%		100

4.2 Traffic Distribution

Traffic distribution to and from the development has been assessed based upon the position of the main roads near the site and likelihood of vehicles driving to particular locations. Considerations taken for the assessment include (however are not limited to):

- Residential areas; and
- Other public transport infrastructure for vehicular parking in the area.

Figure 17 illustrates the assumed traffic distribution to the site during the AM peak.

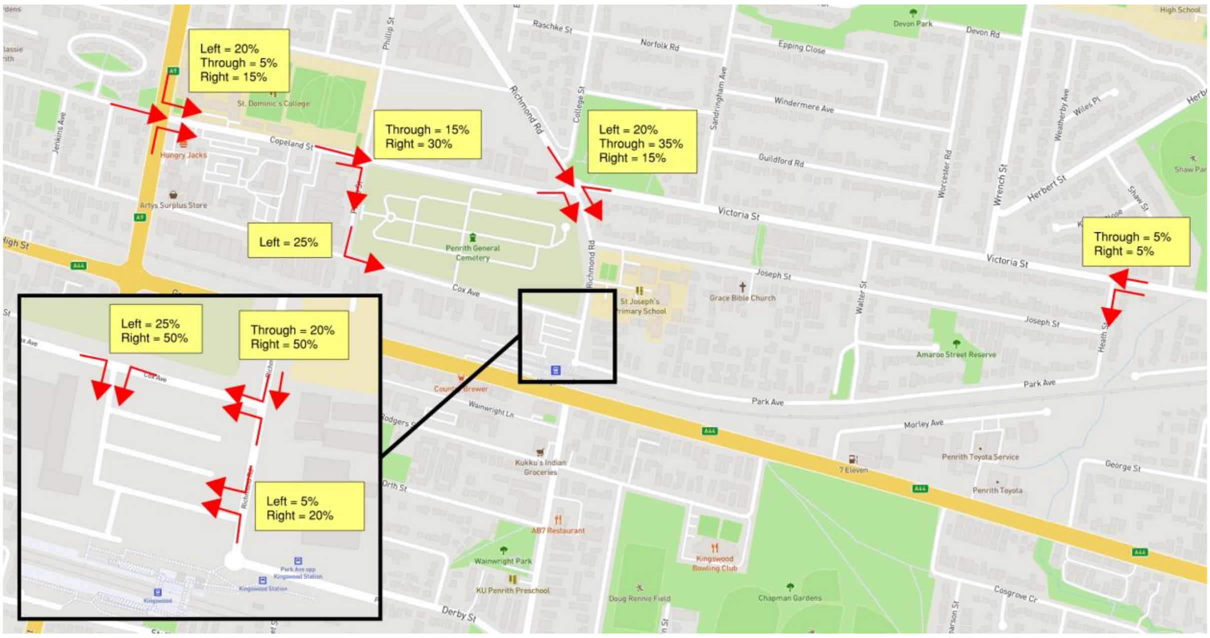


Figure 17 Incoming Traffic Distribution

Figure 18 illustrates the assumed traffic distribution from the site during the PM period.

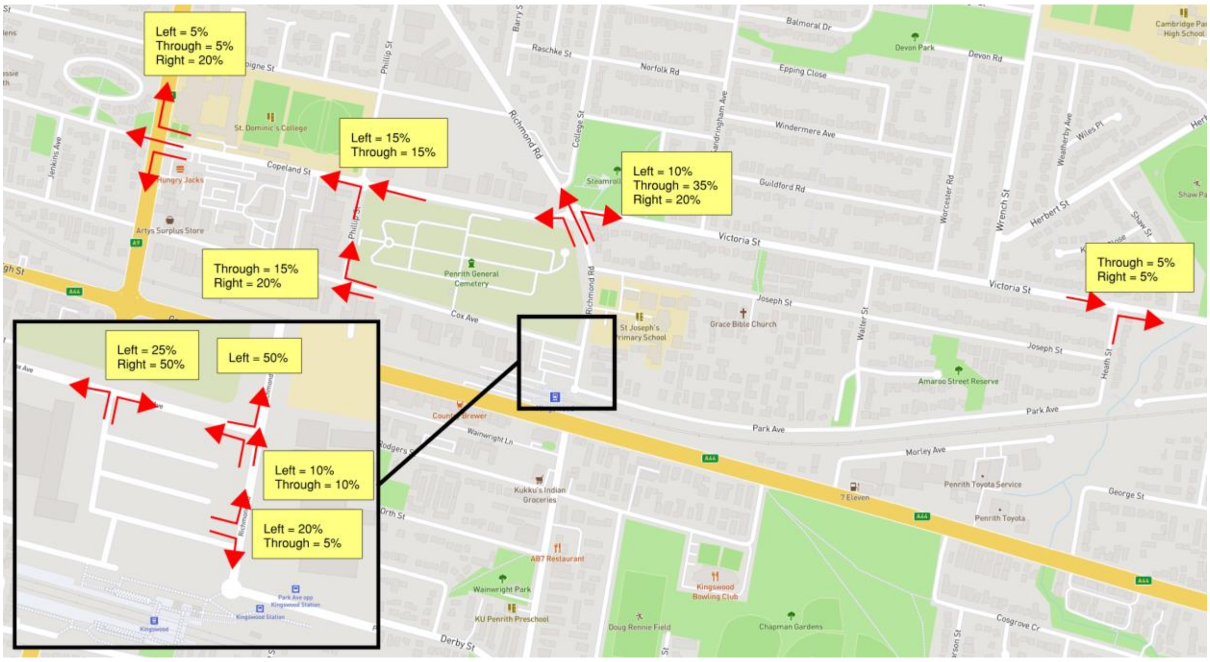


Figure 18 Outgoing Traffic Distribution

4.3 Traffic Impact

The performance of key intersections has been reviewed for the development conditions and the future conditions.

For the purpose of this Traffic Impact Assessment Report, it has been assumed that the development year will be 2023 and the future conditions year will be 2033.

It is assumed that the traffic generated by the proposed development will not increase in the future based on its usage as defined by this report.

The increase in traffic on the roads will increase by 2% per year as advised by RP by email on 21 March, 2022.

The following subsections go through the performance of the key intersections for both the development conditions and the future conditions.

4.3.1 Development Conditions – 2023

4.3.1.1 Parker Street and Copeland Street

The intersection of Parker Street and Copeland Street has been modelled using SIDRA Intersection 9 for the development conditions.

Due to onsite observations, Northrop has changed the traffic light sequence from the SCATS graphic provided by TfNSW to a sequence which more closely aligns to that onsite.

Figure 19 illustrates a comparison of the LOS for the AM and PM peak periods for the intersection of Parker Street and Copeland Street for both the existing conditions and development conditions.

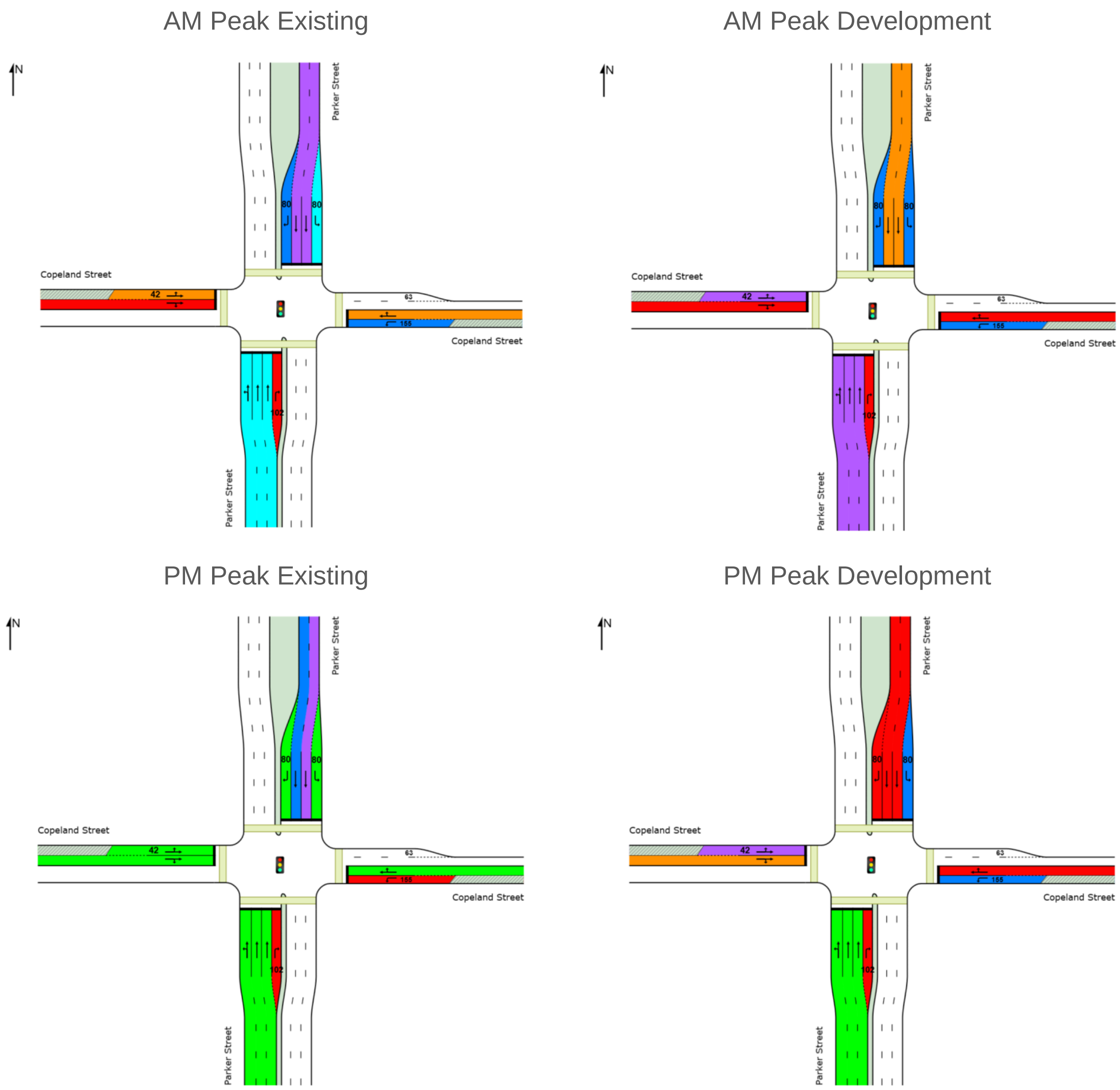


Figure 19 LOS Comparison for Parker Street and Copeland Street Existing and Development Conditions

A summary of the results is available in Table 10.

Table 10 SIDRA Intersection Results for the Intersection of Parker Street and Copeland Street Development Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Parker Street North	AM	E	0.957	66.8	498
Copeland Street West		E	0.745	67.7	76
Parker Street South		E	0.953	56.9	204
Copeland Street East		D	0.643	43.8	198
Parker Street North	PM	F	0.983	86.4	508
Copeland Street West		E	0.413	60.9	52
Parker Street South		B	0.982	27.4	230
Copeland Street East		D	0.944	50.1	164

From the results in Table 10 associated with the intersection summary, it is noted that the intersection as a whole for the AM is considered to be at capacity and for the PM is to be considered operating near capacity in line with the RTA Guide to Traffic Generating Developments (2002).

It is noted that the performance of the intersection has reduced when compared to the current conditions for both the AM and PM peak periods however the major contribution to this would be the additional traffic growth from the surrounding area rather than the proposed car park.

4.3.1.2 Copeland Street and Phillip Street

The intersection of Copeland Street and Phillip Street has been modelled using SIDRA Intersection 9 for the development conditions.

Figure 20 illustrates a comparison of the LOS for the AM and PM peak periods for the intersection of Copeland Street and Phillip Street for both the existing conditions and development conditions.

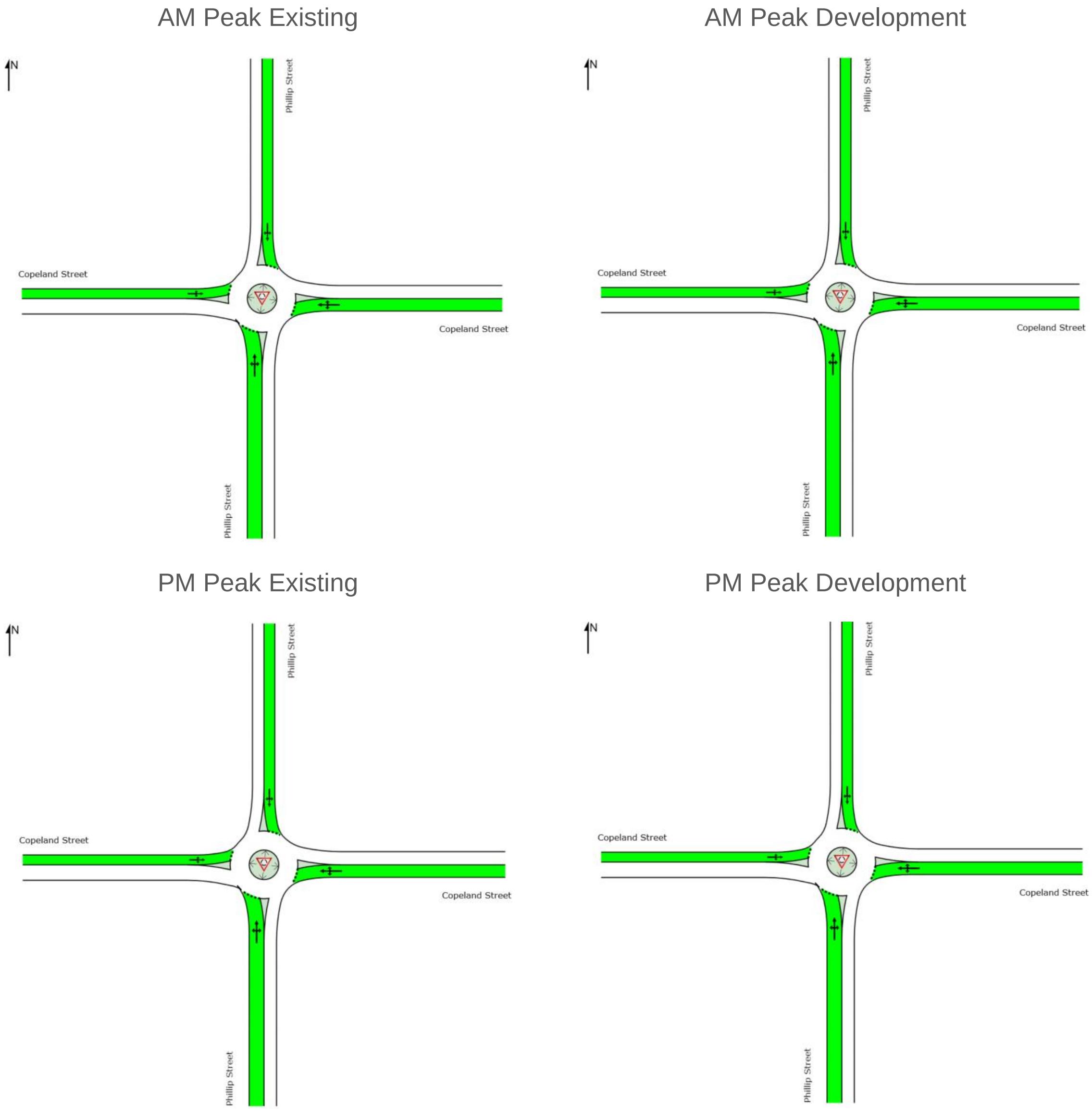


Figure 20 LOS Comparison for Copeland Street and Phillip Street Existing and Development Conditions

A summary of the results is available in Table 11.

Table 11 SIDRA Intersection Results for the Intersection of Copeland Street and Phillip Street Development Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Phillip Street North	AM	A	0.135	8.9	6
Copeland Street West		A	0.424	4.9	25
Phillip Street South		A	0.088	9.1	4
Copeland Street East		A	0.654	7.0	48
Phillip Street North	PM	A	0.059	10.2	3
Copeland Street West		A	0.395	4.0	24
Phillip Street South		A	0.136	8.4	5
Copeland Street East		A	0.511	4.2	34

From the results in Table 13, it can be seen that the intersection is anticipated to have free flowing conditions with minimal delays or queuing once the proposed car park is operational for both the AM and PM peak periods.

It is noted that the performance of the intersection has reduced when compared to the current conditions for both the AM and PM peak periods however the major contribution to this would be the additional traffic growth from the surrounding area rather than the proposed car park.

4.3.1.3 Copeland Street and Richmond Road

The intersection of Copeland Street and Richmond Road has been modelled using SIDRA Intersection 9 for the development conditions.

Figure 21 illustrates a comparison of the LOS for the AM and PM peak periods for the intersection of Copeland Street and Richmond Road for both the existing conditions and development conditions.

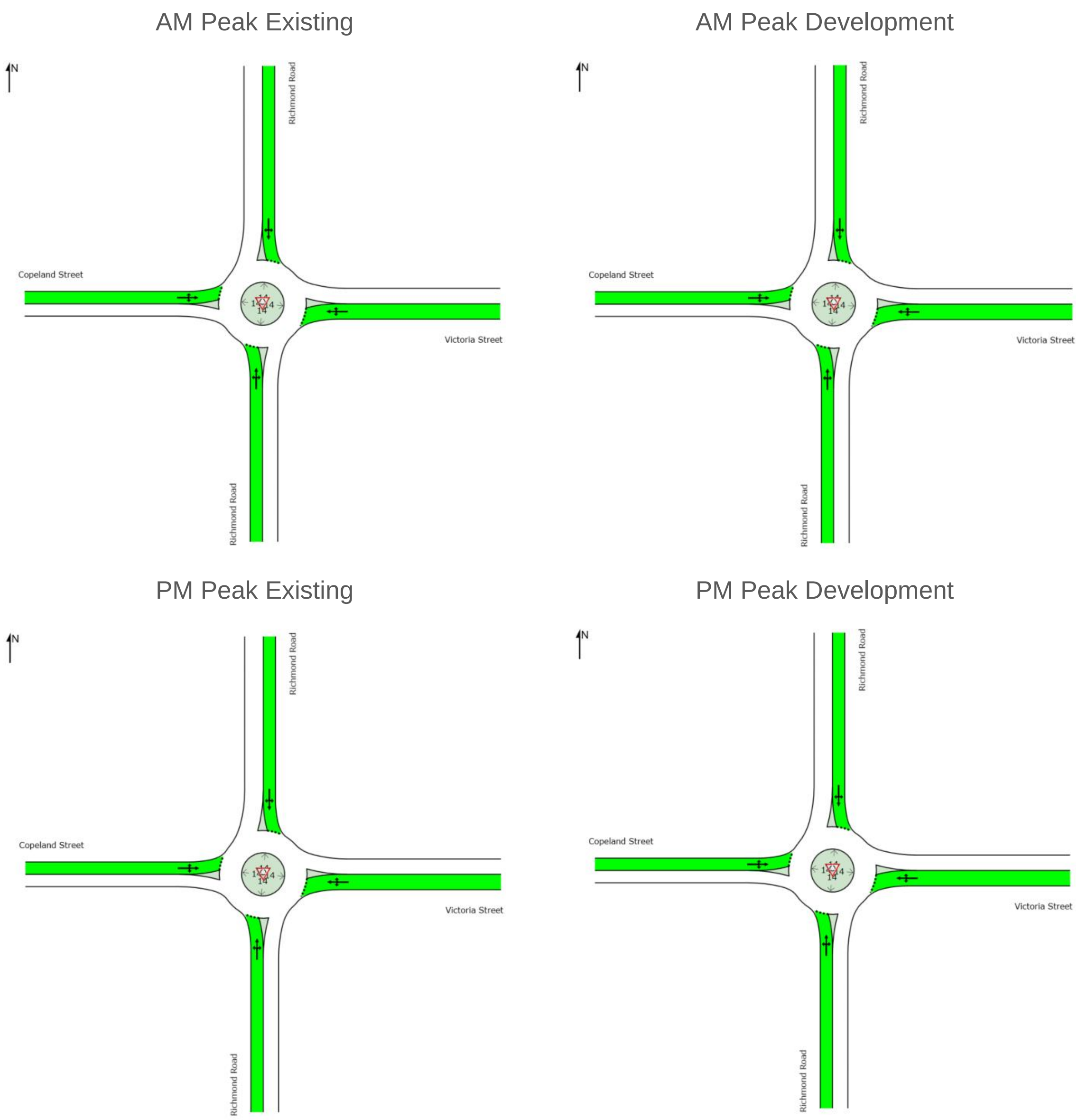


Figure 21 LOS Comparison for Copeland Street and Richmond Street Existing and Development Conditions

A summary of the results is available in Table 12.

Table 12 SIDRA Intersection Results for the Intersection of Copeland Street and Richmond Road Development Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Richmond Road North	AM	A	0.417	7.2	20
Copeland Street		A	0.311	5.9	14
Richmond Road South		A	0.324	10.1	14
Victoria Street		A	0.618	7.9	37
Richmond Road North	PM	A	0.298	8.1	14
Copeland Street		A	0.540	6.9	31
Richmond Road South		A	0.415	11.4	20
Victoria Street		A	0.613	6.2	34

From the results in Table 12, it can be seen that the intersection is anticipated to have free flowing conditions with minimal delays or queuing once the proposed car park is operational for both the AM and PM peak periods.

It is noted that the performance of the intersection has reduced when compared to the current conditions for both the AM and PM peak periods however the major contribution to this would be the additional traffic growth from the surrounding area rather than the proposed car park.

4.3.1.4 Victoria Street and Heath Street

The intersection of Victoria Street and Heath Street has been modelled using SIDRA Intersection 9 for the development conditions.

Figure 22 illustrates a comparison of the LOS for the AM and PM peak periods for the intersection of Victoria Street and Heath Street for both the existing conditions and development conditions.

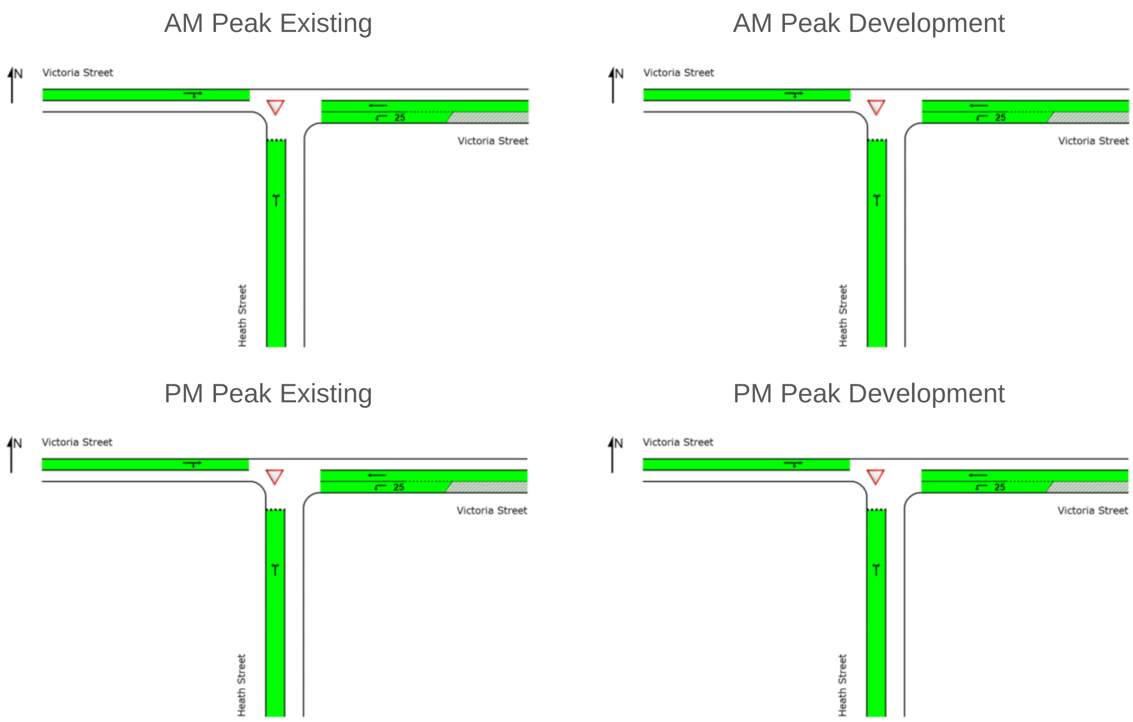


Figure 22 LOS Comparison for Victoria Street and Heath Street Existing and Development Conditions

A summary of the results is available in Table 13.

Table 13 SIDRA Intersection Results for the Intersection of Victoria Street and Heath Street Development Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Victoria Street East		N/A	0.187	0.5	0
Victoria Street West	AM	N/A	0.155	0.6	1
Heath Street		A	0.049	9.3	1
Victoria Street East		N/A	0.284	0.5	0
Victoria Street West	PM	N/A	0.168	0.2	1
Heath Street		A	0.081	12.2	2

From the results in Table 13, it can be seen that the intersection is anticipated to have free flowing conditions with minimal delays or queuing once the proposed car park is operational for both the AM and PM peak periods.

It is noted that the performance of the intersection has insignificantly become worse when compared to the current conditions for both the AM and PM peak periods.

4.3.1.5 Cox Avenue and Richmond Road

The intersection of Cox Avenue and Richmond Road has been modelled using SIDRA Intersection 9 for the development conditions.

Figure 23 illustrates a comparison of the LOS for the AM and PM peak periods for the intersection of Cox Avenue and Richmond Road for both the existing conditions and development conditions.

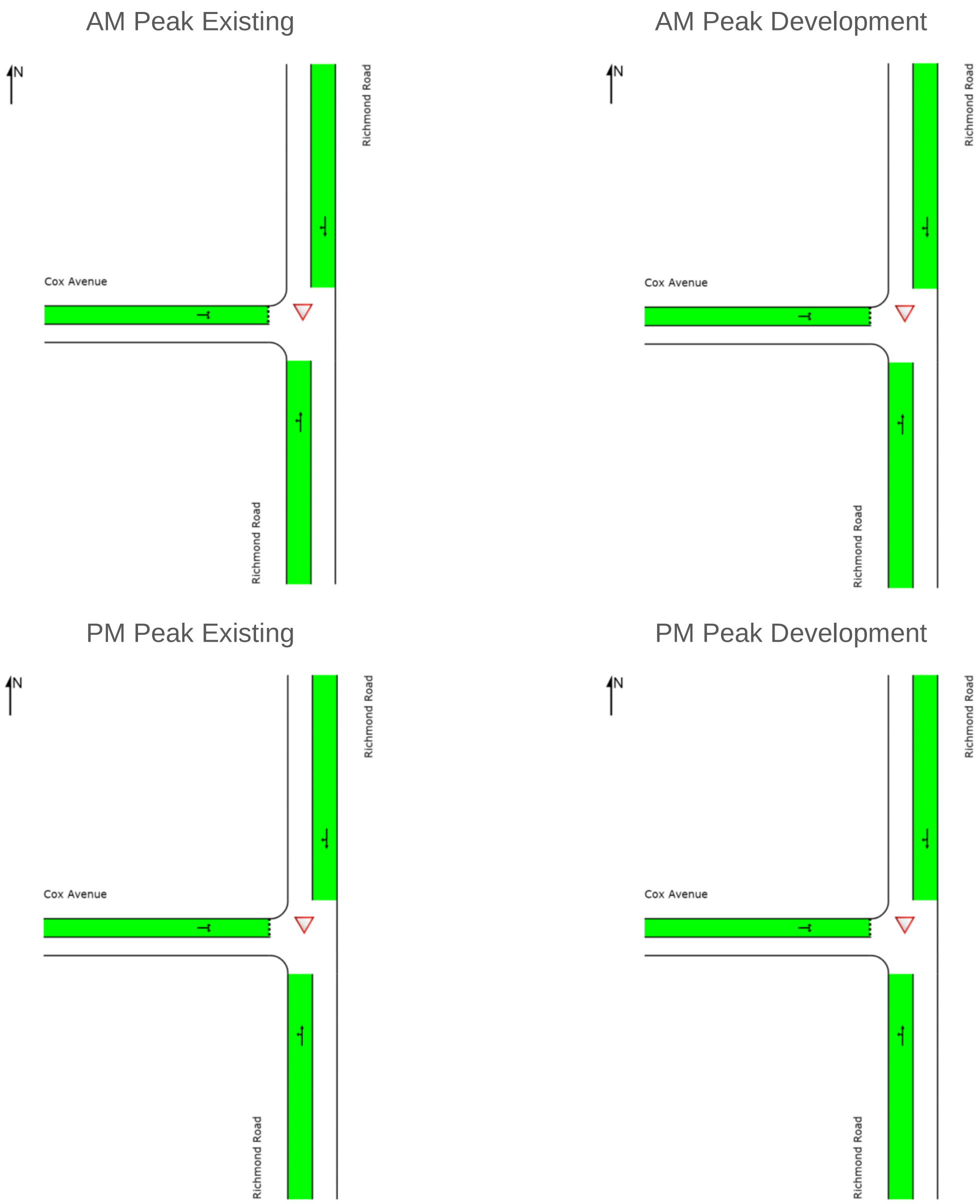


Figure 23 LOS Comparison for Victoria Street and Heath Street Existing and Development Conditions

A summary of the results is available in Table 14.

Table 14 SIDRA Intersection Results for the Intersection of Cox Avenue and Richmond Road Development Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Richmond Road North	AM	N/A	0.121	3.0	4
Richmond Road South		N/A	0.031	1.8	0
Cox Avenue		A	0.024	5.0	1
Richmond Road North	PM	N/A	0.070	2.5	2
Richmond Road South		N/A	0.054	1.4	0
Cox Avenue		A	0.073	4.9	2

From the results in Table 14, it can be seen that the intersection is anticipated to have free flowing conditions with minimal delays or queuing once the proposed car park is operational for both the AM and PM peak periods.

It is noted that the performance of the intersection has insignificantly become worse when compared to the current conditions for both the AM and PM peak periods.

4.3.2 Future Conditions – 2033

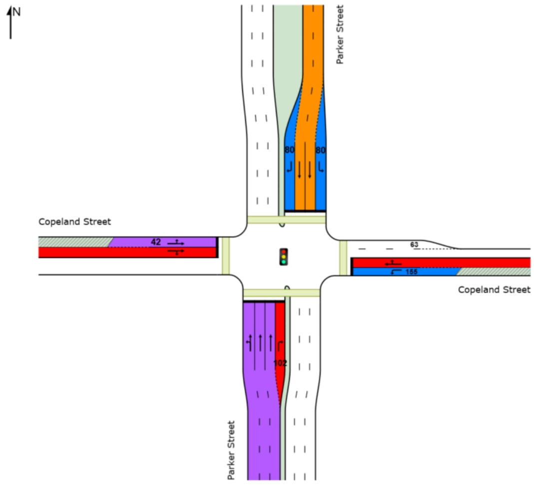
4.3.2.1 Parker Street and Copeland Street

The intersection of Parker Street and Copeland Street has been modelled using SIDRA Intersection 9 for the future conditions – 2033.

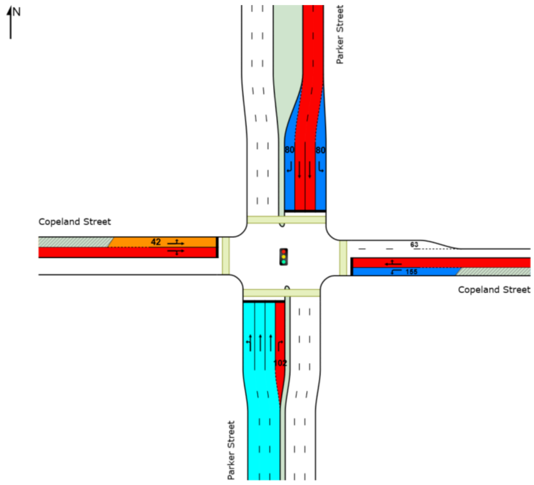
Due to onsite observations, Northrop has changed the traffic light sequence from the SCATS graphic provided by TfNSW to a sequence which more closely aligns to that onsite.

Figure 24 illustrates a comparison of the LOS for the AM and PM peak periods for the intersection of Parker Street and Copeland Street for both the development conditions and future conditions.

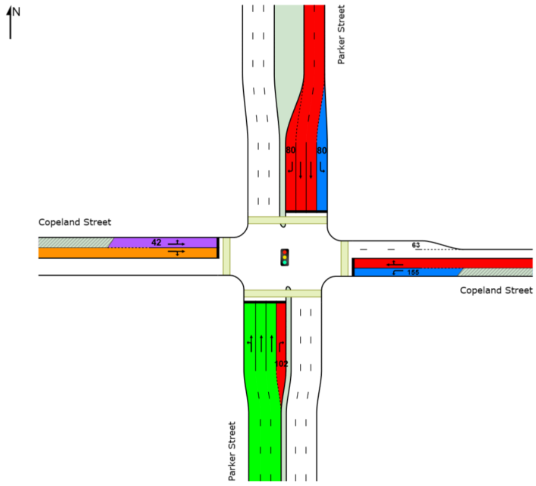
AM Peak Development



AM Peak Future



PM Peak Development



PM Peak Future

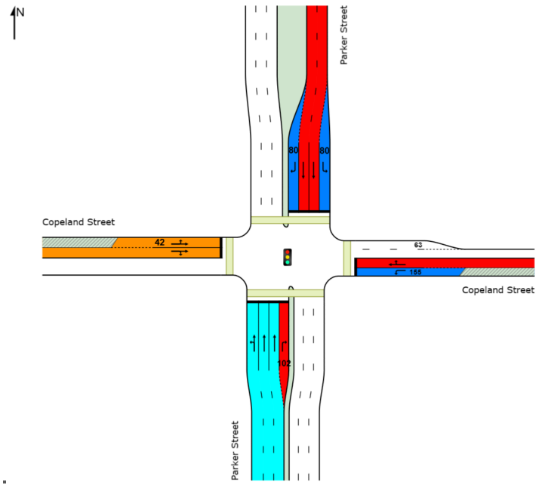


Figure 24 LOS Comparison for Parker Street and Copeland Street Development and Future Conditions

A summary of the results is available in Table 15.

Table 15 SIDRA Intersection Results for the Intersection of Parker Street and Copeland Street Future Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Parker Street North	AM	F	1.201	240.4	1,111
Copeland Street West		F	1.203	143.2	111
Parker Street South		F	1.198	79.8	550
Copeland Street East		D	0.749	44.2	262
Parker Street North	PM	F	1.196	238.1	1,009
Copeland Street West		E	0.494	63.8	63
Parker Street South		F	1.197	70.7	493
Copeland Street East		F	1.173	92.2	244

From the results in Table 15 associated with the intersection summary, it is noted that the whole intersection for the AM and PM is considered to be operating over capacity.

It is noted that the performance of the intersection has decreased when compared to the development conditions for both the AM and PM peak periods, however this would be due to traffic not associated with the new development in the surrounding area.

The SIDRA Intersection model for the intersection of Parker Street and Copeland Street indicates the need for this intersection to be further reviewed which is beyond the scope of this report as the decrease in performance of the intersection is generally from traffic which is not generated by the proposed development.

4.3.2.2 Copeland Street and Phillip Street

The intersection of Copeland Street and Phillip Street has been modelled using SIDRA Intersection 9 for the future conditions – 2033.

Figure 25 illustrates a comparison of the LOS for the AM and PM peak periods for the intersection of Copeland Street and Phillip Street for both the development conditions and future conditions.

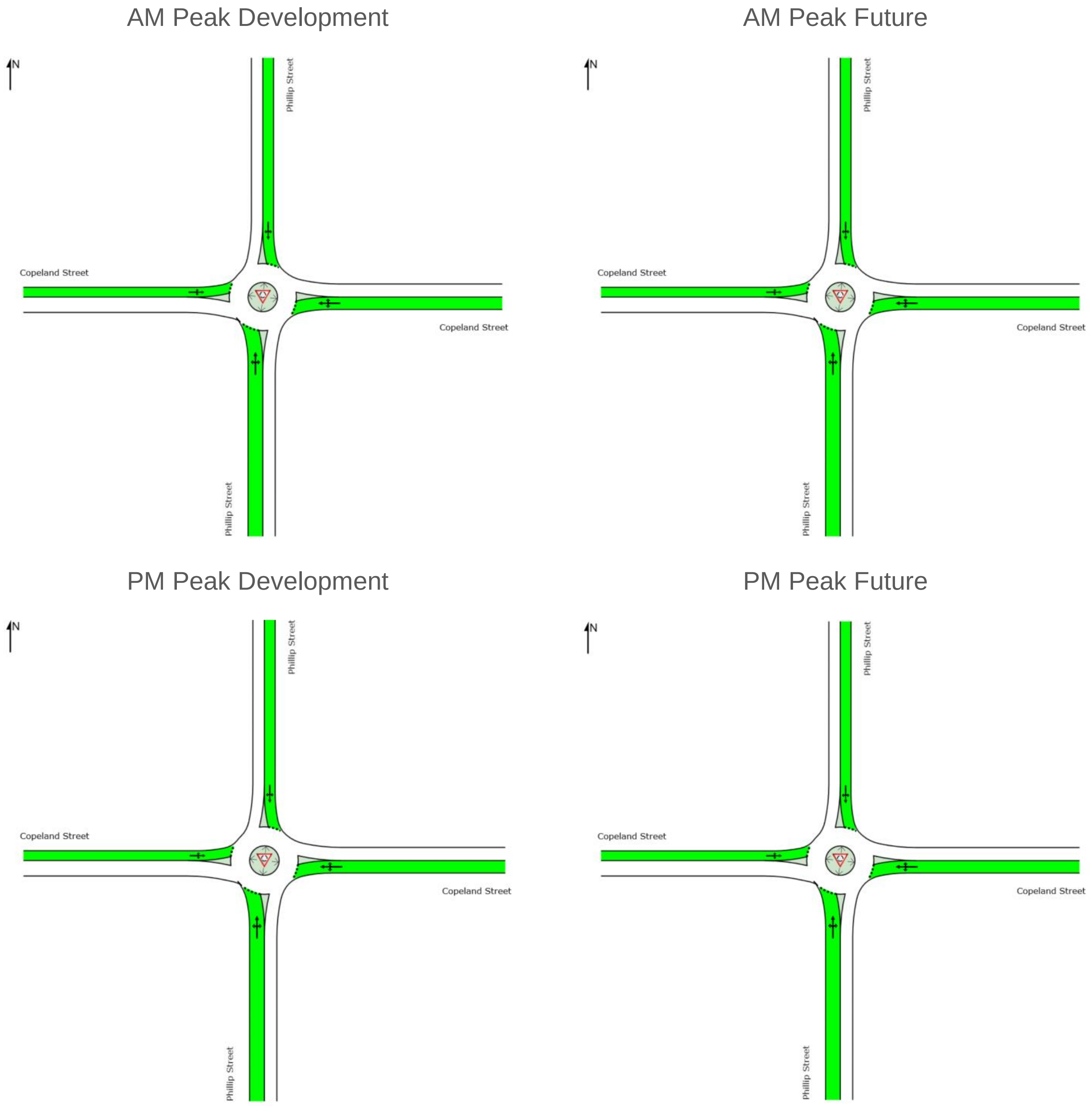


Figure 25 LOS Summary Copeland Street and Phillip Street Existing Conditions

A summary of the results is available in Table 16.

Table 16 SIDRA Intersection Results for the Intersection of Copeland Street and Phillip Street Future Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Phillip Street North	AM	A	0.175	9.7	8
Copeland Street West		A	0.508	5.1	35
Phillip Street South		A	0.125	10.5	5
Copeland Street East		A	0.820	12.7	105
Phillip Street North	PM	A	0.073	11.6	4
Copeland Street West		A	0.493	4.2	49
Phillip Street South		A	0.182	9.8	7
Copeland Street East		A	0.616	4.4	34

From the results in Table 16, it can be seen that the intersection is anticipated to be good with acceptable delays and spare capacity once the proposed car park is operational for 10 years for both the AM and PM peak periods.

It is noted that the performance of the intersection has decreased when compared to the development conditions for both the AM and PM peak periods, however this would be due to traffic not associated with the new development in the surrounding area.

The SIDRA Intersection model for the intersection of Copeland Street and Phillip Street does not indicate the need for this intersection to be upgraded based on this development for the future conditions – 2033 scenario.

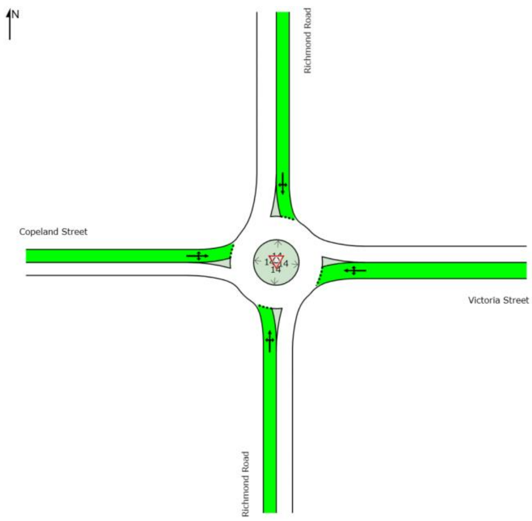
However, Penrith City Council is to monitor the performance of this intersection to determine if intersection modifications are required post construction of the Kingswood Commuter car park based on safety concerns, additional development in the area or any other determining factors.

4.3.2.3 Copeland Street and Richmond Road

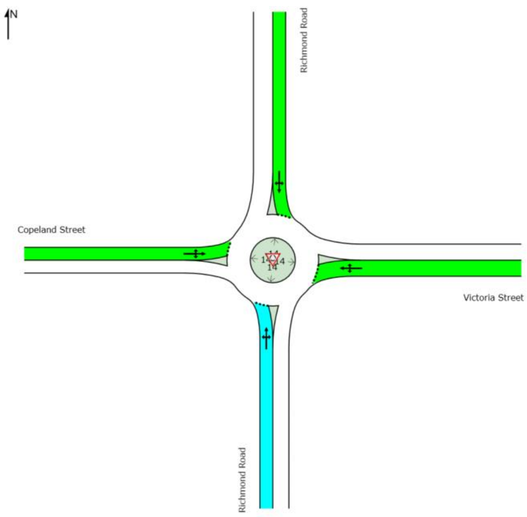
The intersection of Copeland Street and Richmond Road has been modelled using SIDRA Intersection 9 for the future conditions – 2033.

Figure 26 illustrates a comparison of the LOS for the AM and PM peak periods for the intersection of Copeland Street and Richmond Road for both the development conditions and future conditions.

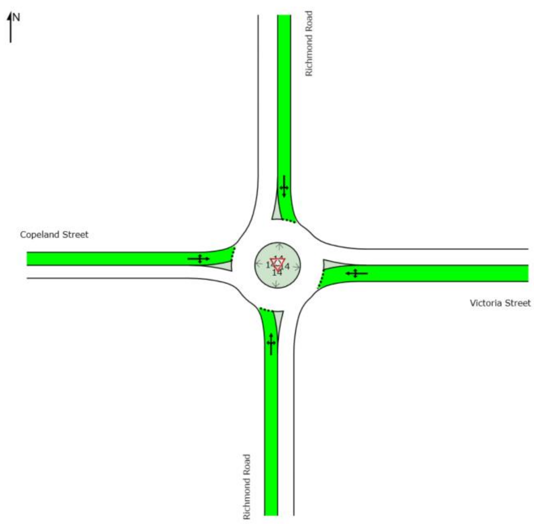
AM Peak Development



AM Peak Future



PM Peak Development



PM Peak Future

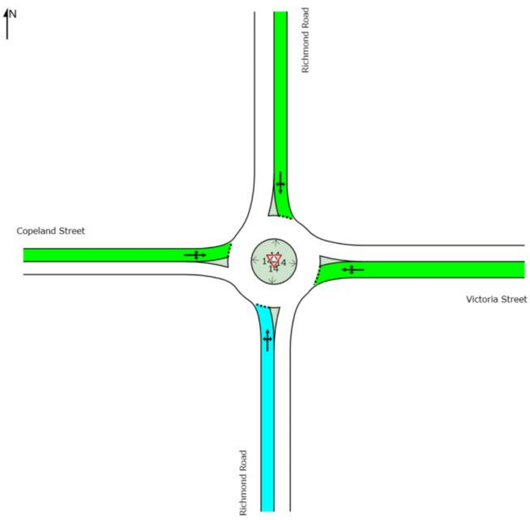


Figure 26 LOS Comparison for Copeland Street and Richmond Street Development and Future Conditions

A summary of the results is available in Table 17.

Table 17 SIDRA Intersection Results for the Intersection of Copeland Street and Richmond Road Future Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Richmond Road North	AM	A	0.528	8.5	30
Copeland Street		A	0.391	6.4	19
Richmond Road South		B	0.483	14.7	26
Victoria Street		A	0.792	12.2	71
Richmond Road North	PM	A	0.403	9.1	21
Copeland Street		A	0.685	9.8	55
Richmond Road South		B	0.601	18.6	38
Victoria Street		A	0.778	9.3	69

From the results in Table 17, it can be seen that the intersection is anticipated to be good with acceptable delays and spare capacity once the proposed car park is operational for 10 years for both the AM and PM peak periods.

It is noted that the performance of the intersection has decreased when compared to the development conditions for both the AM and PM peak periods, however this would be due to traffic not associated with the new development in the surrounding area.

The SIDRA Intersection model for the intersection of Copeland Street and Richmond Road does not indicate the need for this intersection to be upgraded based on this development.

However, Penrith City Council is to monitor the performance of this intersection to determine if intersection modifications are required post construction of the Kingswood Commuter car park based on safety concerns, additional development in the area or any other determining factors.

4.3.2.4 Victoria Street and Heath Street

The intersection of Victoria Street and Heath Street has been modelled using SIDRA Intersection 9 for the future conditions – 2033.

Figure 27 illustrates a comparison of the LOS for the AM and PM peak periods for the intersection of Victoria Street and Heath Street for both the development conditions and future conditions.

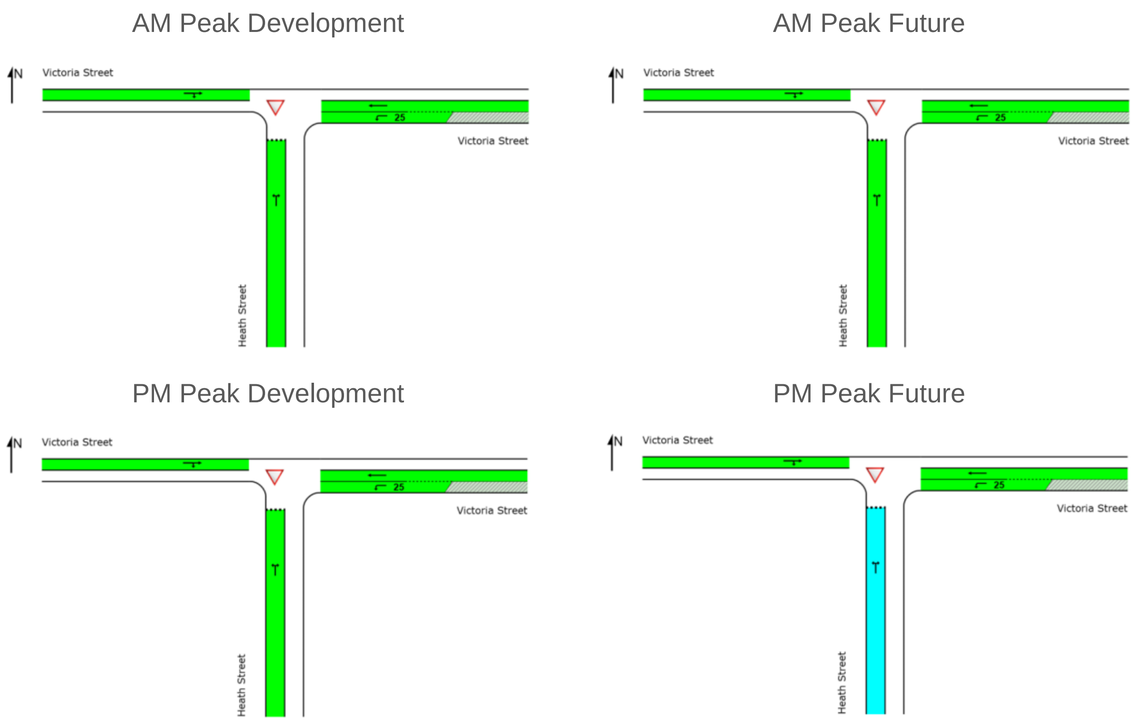


Figure 27 LOS Comparison for Victoria Street and Heath Street Development and Future Conditions

A summary of the results is available in Table 18.

Table 18 SIDRA Intersection Results for the Intersection of Victoria Street and Heath Street Future Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Victoria Street East	AM	N/A	0.226	0.5	0
Victoria Street West		N/A	0.188	0.7	2
Heath Street		A	0.065	11.0	2
Victoria Street East	PM	N/A	0.347	0.5	0
Victoria Street West		N/A	0.203	0.3	1
Heath Street		B	0.131	16.0	3

From the results in Table 18, it can be seen that the intersection is anticipated to have free flowing conditions with minimal delays or queuing once the proposed car park is operational for 10 years for both the AM and PM peak periods.

It is noted that the performance of the intersection has decreased when compared to the development conditions for both the AM and PM peak periods, however this would be due to traffic not associated with the new development in the surrounding area.

The SIDRA Intersection model for the intersection of Victoria Street and Heath Street does not indicate the need for this intersection to be upgraded based on this development.

However, Penrith City Council is to monitor the performance of this intersection to determine if intersection modifications are required post construction of the Kingswood Commuter car park based on safety concerns, additional development in the area or any other determining factors.

4.3.2.5 Cox Avenue and Richmond Road

The intersection of Cox Avenue and Richmond Road has been modelled using SIDRA Intersection 9 for the future conditions – 2033.

Figure 28 illustrates a comparison of the LOS for the AM and PM peak periods for the intersection of Cox Avenue and Richmond Road for both the development conditions and future conditions.

Figure 28 LOS Comparison for Cox Avenue and Richmond Road Development and Future Conditions

A summary of the results is available in Table 19.

Table 19 SIDRA Intersection Results for the Intersection of Cox Avenue and Richmond Road Future Conditions

Leg	Period	LOS	DOS	Average Delay (seconds)	95th percentile Queue length (m)
Richmond Road North	AM	N/A	0.143	3.0	5
Richmond Road South		N/A	0.031	2.1	0
Cox Avenue		A	0.039	5.1	1
Richmond Road North	PM	N/A	0.084	2.6	3
Richmond Road South		N/A	0.081	1.3	0
Cox Avenue		A	0.063	5.0	3

From the results in Table 19, it can be seen that the intersection is anticipated to have free flowing conditions with minimal delays or queuing once the proposed car park is operational for 10 years for both the AM and PM peak periods.

It is noted that the performance of the intersection has insignificantly become worse when compared to the development conditions for both the AM and PM peak periods.

The SIDRA Intersection model for the intersection of Cox Avenue and Richmond Road does not indicate the need for a roundabout at this intersection based on this development.

However, Penrith City Council is to monitor the performance of this intersection to determine if a roundabout is required post construction of the Kingswood Commuter car park based on safety concerns, additional development in the area or any other determining factors.

4.4 Parking Impact

As per Section 3.4.1 of this report, the proposed development provides more car parking spaces than required from a brief issued by RP.

The proposed development also provides motorcycle in addition to the project brief and the Penrith City Council Penrith DCP 2014.

The development introduces 303 new car parking spaces to the area. As residential development densifies through the suburb of Kingswood and surrounding area, this car park will assist in providing a facility for commuters to leave their car at through the day to remove vehicles from the routes to working destinations covered by public transport.

4.5 Construction Traffic Management Plan

Northrop Consulting Engineers have not been engaged to include any construction traffic management plan commentary. Northrop Consulting Engineers advise this will need to be considered prior to the commencement of construction.

Any construction traffic management plans should be prepared in accordance with RMS and Penrith City Council Requirements by a suitably qualified and experienced Temporary Traffic Management Specialist and approved by relevant authorities.

4.6 Assessment of Traffic Noise

Northrop Consulting Engineers has not completed an Assessment of the noise attenuation measures for the proposed car park. The client is to consider whether it is required to engage a suitably qualified consultant to prepare an acoustic assessment for the proposed development.

5. Conclusion

Northrop Consulting Engineers (NCE) has been engaged by Root Partnerships (RP) to prepare a Traffic Impact Assessment Report on the potential influence of the redevelopment of 6 Cox Avenue, Kingswood.

This Traffic Impact Assessment Report has detailed the below:

- A project description outlining the proposed development;
- The key roads serving the development;
- The traffic activity associated with the development proposal and its impacts upon the surrounding road network;
- Compliance of the proposed carpark, vehicular access and internal circulation arrangements in line with the relevant standards;
- Proposed service vehicle arrangements;
- Traffic generation and trip distribution for the proposed development;
- The proposed development's impact on road safety;
- SIDRA Intersection modelling of the key intersections;
- Existing public transport services in the vicinity of the proposed development;
- Impact of generated traffic on key adjacent intersections;
- Safety and efficiency of access between the site and the adjacent road network;
- Peak period traffic volumes and congestion levels at key adjacent intersections; and
- AADT on key adjacent roads.

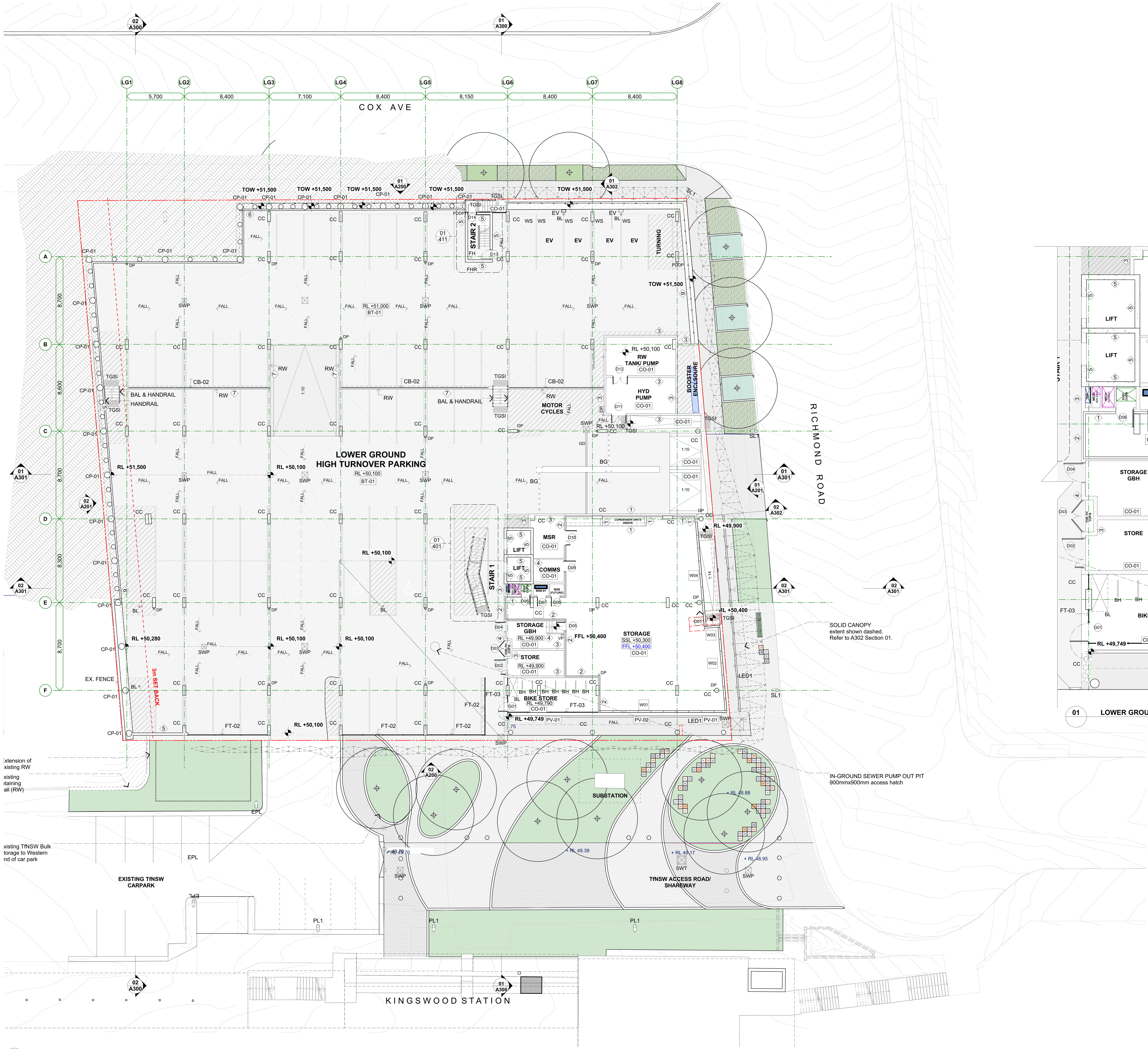
The report has identified:

- The parking survey undertaken indicates that the car parks are not at 100% capacity, however over the 3 car parks, 46 of the 262 available spaces are unoccupied by 10:00am. Of these 46 spaces, 31 are located in the TfNSW car park North of the railway.
- The existing Kingswood commuter car park will generate vehicle movements equal to approximately 23.7% of the total number of car parking spaces during the AM peak period as a conservative estimate for the peak period of 7:45am to 8:45am.
- Under existing conditions, the SIDRA results showed that the intersection of Parker Street and Copeland Street performed satisfactorily in line with the RTA Guide to Traffic Generating Developments (2002). The intersections of Copeland Street and Phillip Street, Copeland Street and Richmond Road, Victoria Street and Heath Street; and Cox Avenue and Richmond Road all had free flowing conditions with minimal delays.
- The proposed carpark generally complied with the relevant standards, codes and guidelines.
- 421 car parking spaces have been proposed which exceeds the 410 car parking spaces as required by the brief.
- Under development conditions (taken as 2023), the intersections of Parker Street and Copeland Street; Copeland Street and Phillip Street; and Copeland Street and Richmond Road; the performance of the intersections have reduced when compared to the current conditions for both the AM and PM peak periods however the major contribution to this would be the additional traffic growth from the surrounding area rather than the proposed car park.
- Under development conditions (taken as 2023), the intersections of Victoria Street and Heath Street; and Cox Avenue and Richmond Road, the performance of the intersections have reduced insignificantly.
- Under the future conditions modelled (2033), the SIDRA Intersection model for the intersection of Parker Street and Copeland Street indicates the need for this intersection to be further reviewed

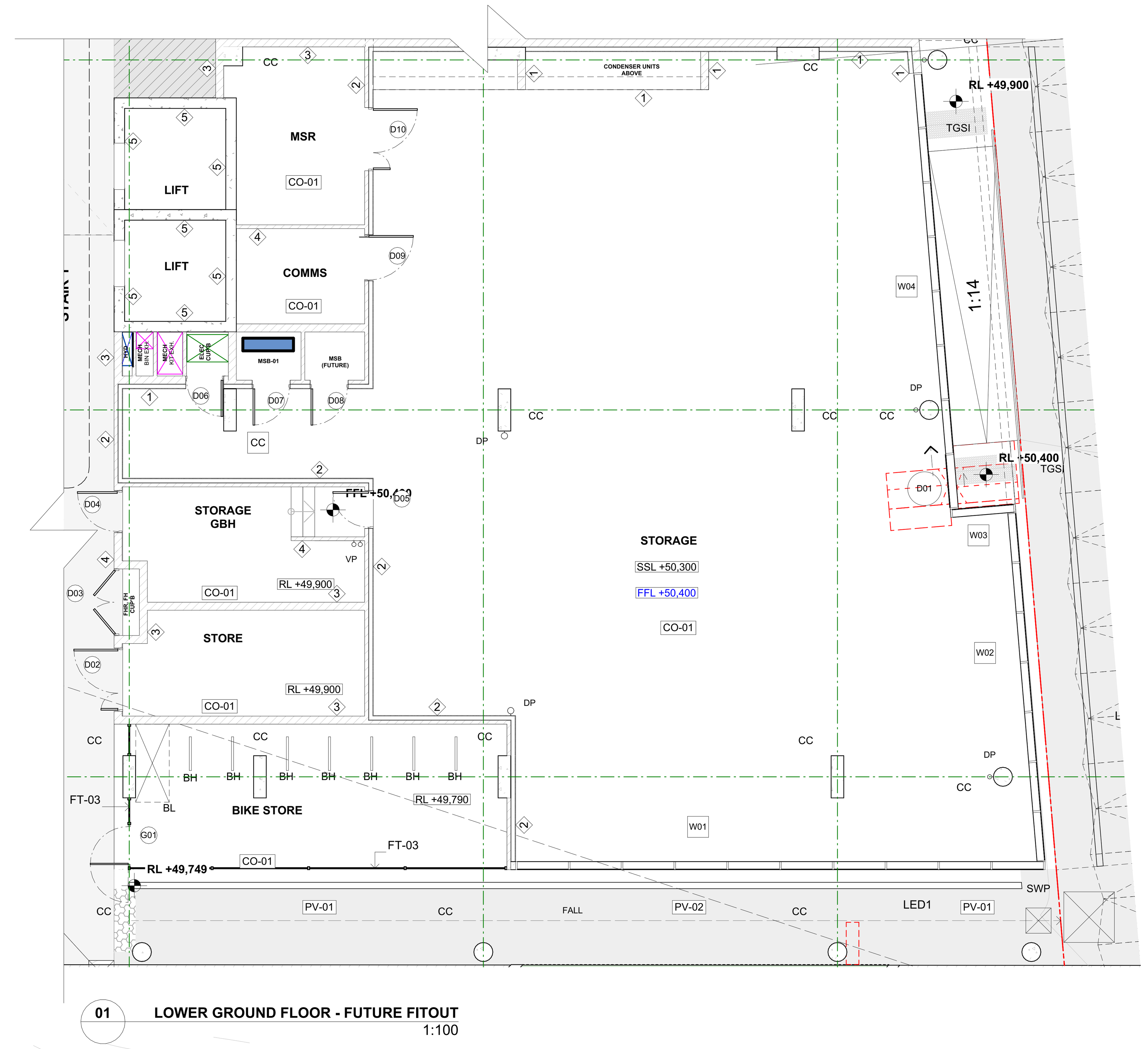
which is beyond the scope of this report as the decrease in performance of the intersection is generally from traffic which is not generated by the proposed development.

- Under the future conditions modelled (2033), the SIDRA Intersection models for the intersections of Copeland Street and Phillip Street, Copeland Street and Richmond Road, Victoria Street and Heath Street; and Cox Avenue and Richmond Road do not indicate the need upgrades to the intersections based on this development.
- A construction traffic management plan will need to be considered for construction works related to this proposed development.
- The client is to consider whether it is required to engage a suitably qualified consultant to prepare an acoustic assessment for the proposed development.

Appendix A Architect Drawings



1 LOWER GROUND GA PLAN
1:200



01 LOWER GROUND FLOOR - FUTURE FITOUT
1:100

ISSUED FOR COORDINATION

0 1 2 4 10 AT A1
0 2 4 8 20 AT A3

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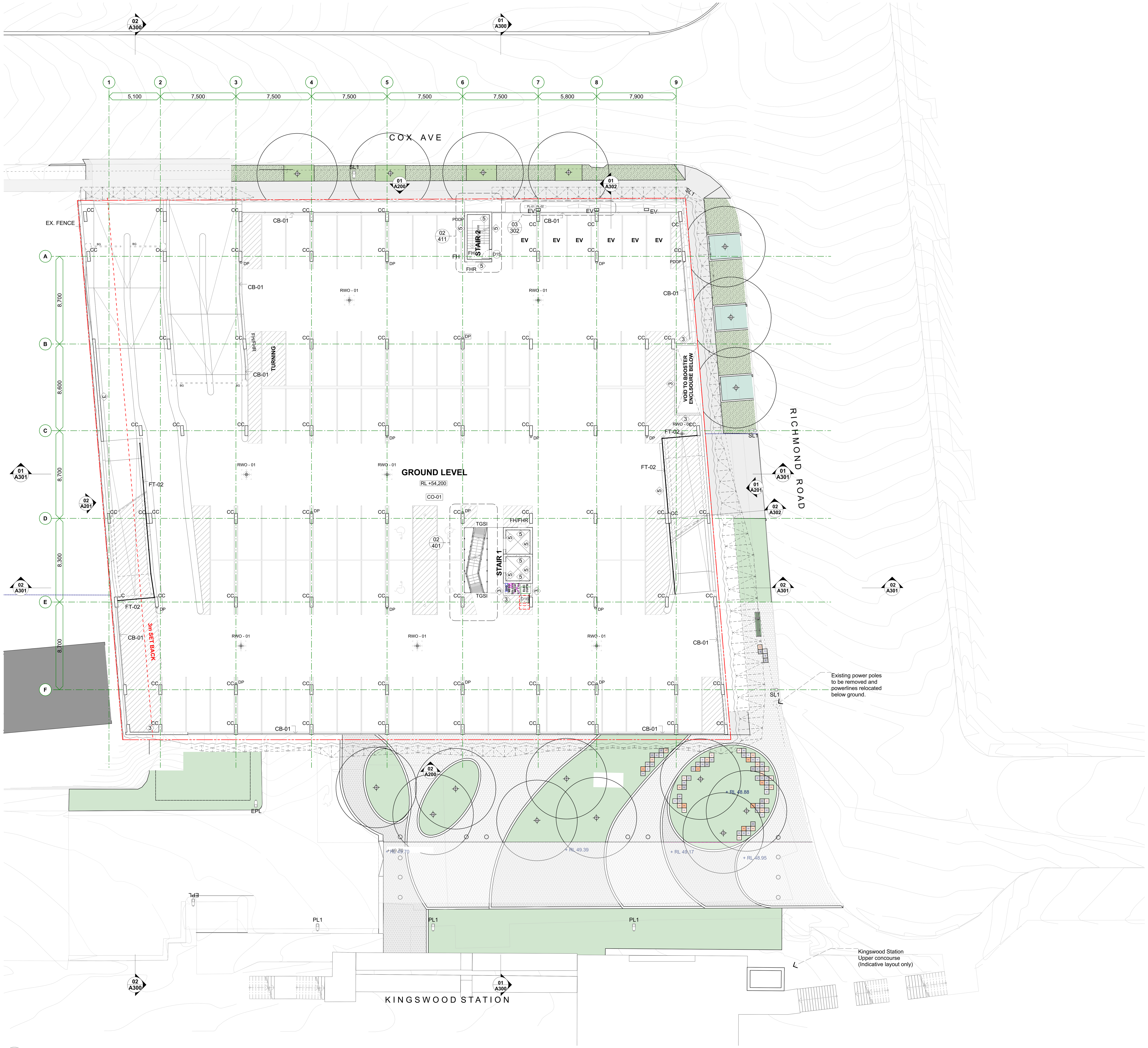
ABN 13 165 409 567 Nominated Architect Sam Crawford 6498

DESCRIPTION	REV	APP'D	DATE
FOR COORDINATION	P1	SC	13/05/2022
FOR COORDINATION	P2	SC	26/05/2022
FOR COORDINATION	P3	SC	3/06/2022
FOR COORDINATION	P4	SC	10/06/2022
FOR COORDINATION	P5	SC	24/06/2022

CLIENT
PENRITH CITY COUNCIL
PROJECT
KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT	SCALE @ A1	PROJECT NO.	STAGE	DRAWING NO.	REV
	1:200, 1:100	21.14	CD	A120	P5

SCALE @ A3
DRAWING TITLE
LOWER GROUND FLOOR GA



1 GROUND FLOOR GA PLAN 1:200

ISSUED FOR COORDINATION

DESCRIPTION	REV	APP'D	DATE
FOR COORDINATION	P1	SC	13/05/2022
FOR COORDINATION	P2	SC	3/06/2022
FOR COORDINATION	P3	SC	10/06/2022
FOR COORDINATION	P4	SC	24/06/2022

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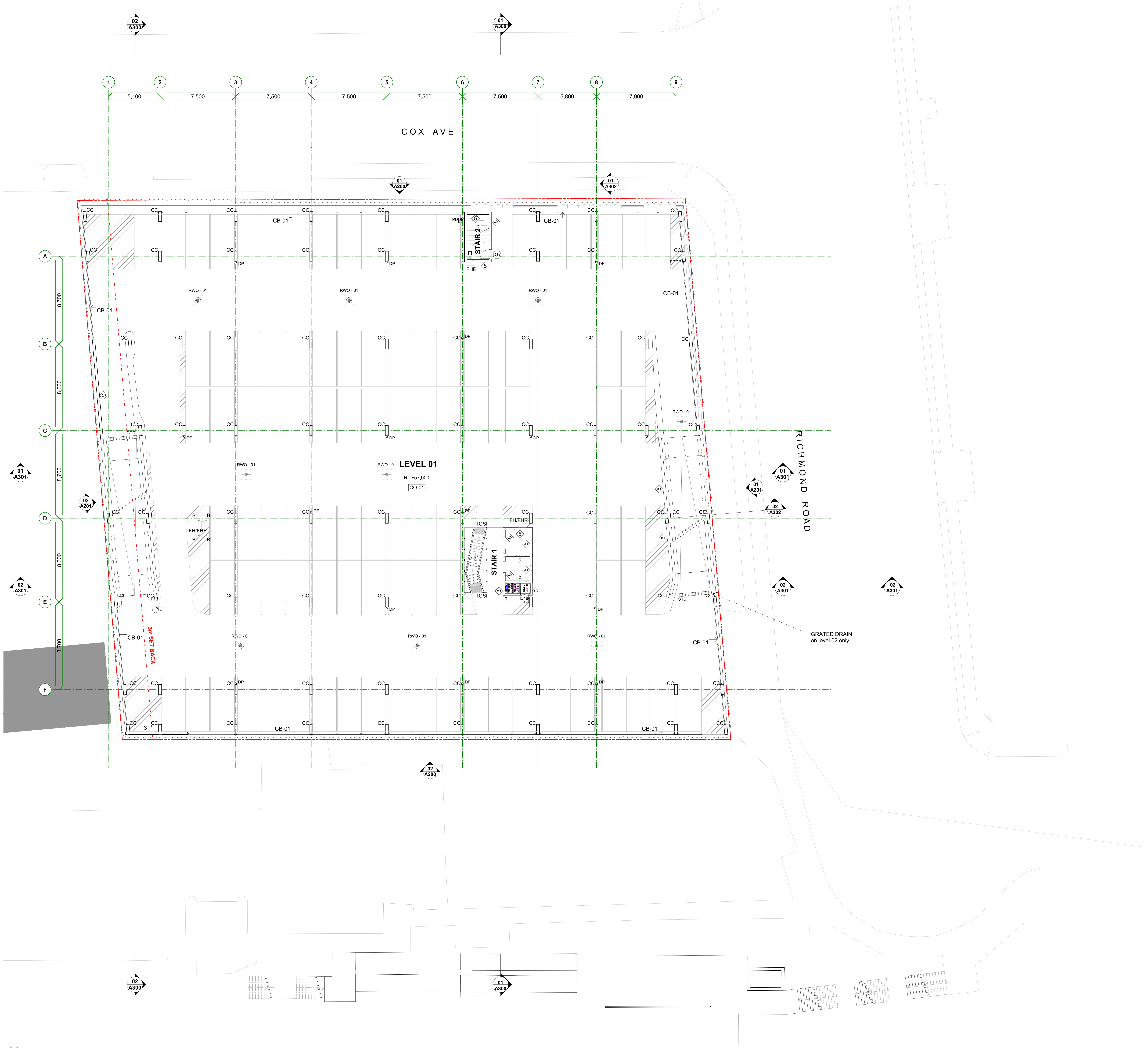
CLIENT: PENRITH CITY COUNCIL
PROJECT: KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

SCALE @ A1: 1:200
PROJECT NO.: 21.14
STAGE: CD
DRAWING NO.: A121
REV: P4
DRAWING TITLE: GROUND FLOOR GA



1 FIRST FLOOR GA PLAN
1:200

ISSUED FOR COORDINATION

0 1 2 4 10 AT A1
0 2 4 8 20 AT A3

LOCI

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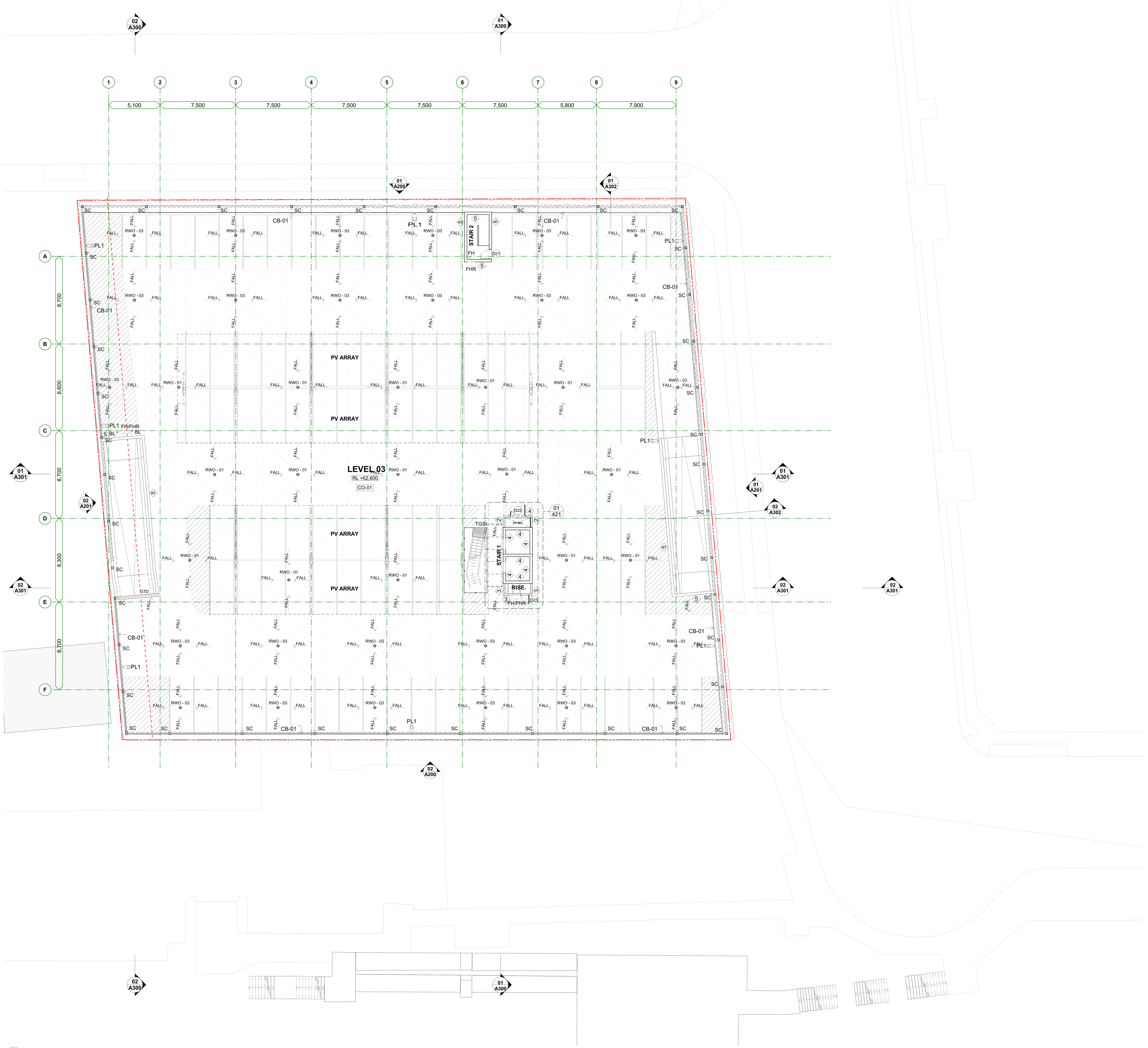
FOR COORDINATION	P2	SC	3/06/2022
FOR COORDINATION	P3	SC	10/06/2022
FOR COORDINATION	P4	SC	24/06/2022

CLIENT
PENRITH CITY COUNCIL
PROJECT
KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT	SCALE @ A1	PROJECT NO.	STAGE	DRAWING NO.	REV
	1:200	21.14	CD	A122	P4

SCALE @ A3
DRAWING TITLE
FIRST + SECOND FLOOR GA



1 THIRD FLOOR GA PLAN
1:200

ISSUED FOR COORDINATION

0 1 2 4 10 AT **A1**
0 2 4 8 20 AT **A3**

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FOR COORDINATION	P3	SC	10/06/2022
FOR COORDINATION	P4	SC	24/06/2022

CLIENT
PENRITH CITY COUNCIL

PROJECT
KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT	SCALE @ A1	PROJECT NO.	STAGE	DRAWING NO.	REV
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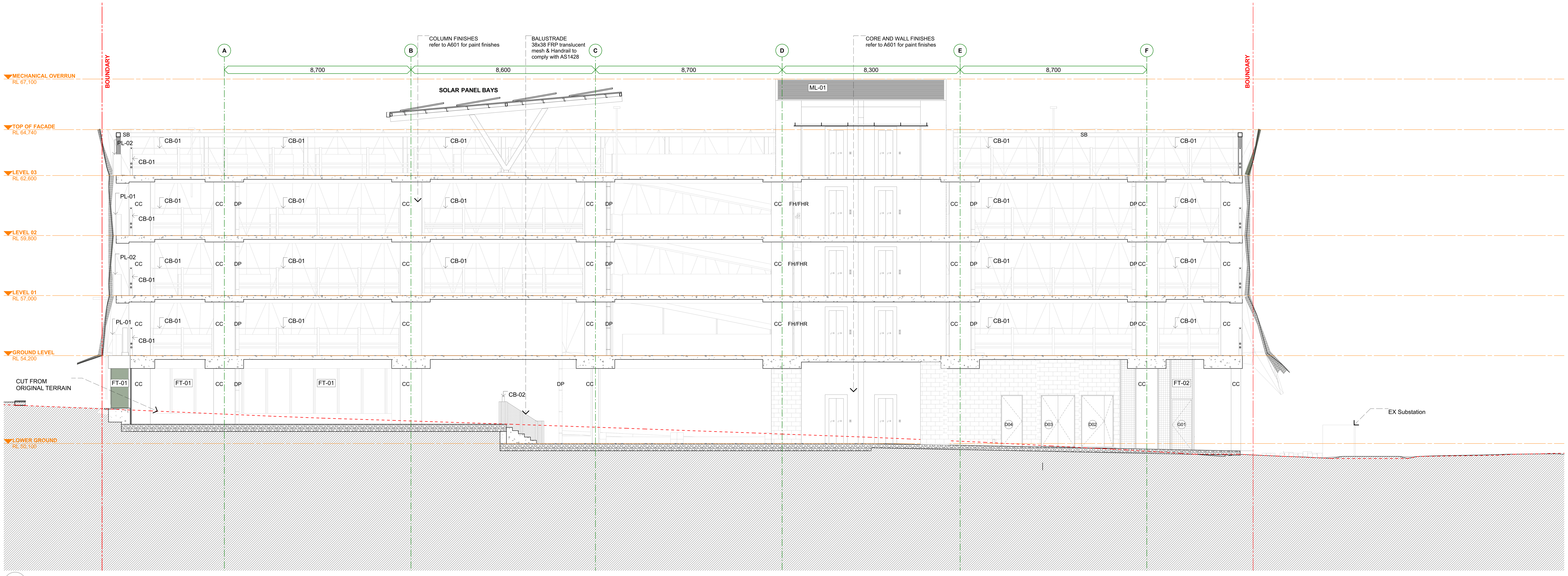
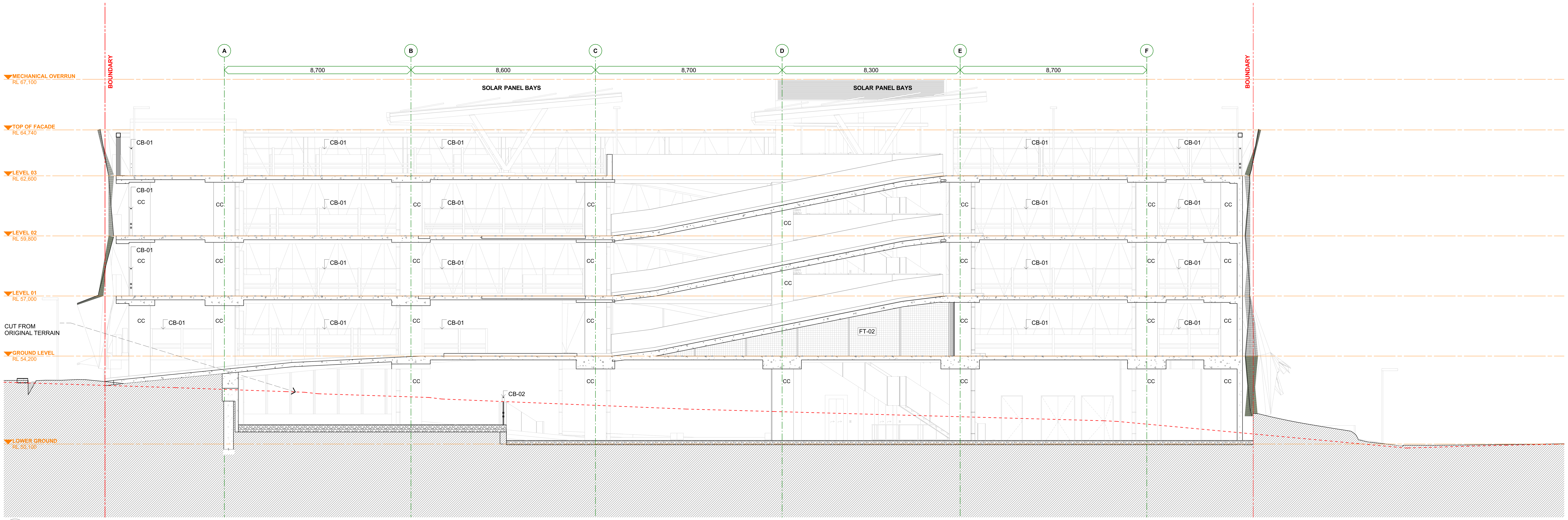
SCALE @ A3

DRAWING TITLE
THIRD FLOOR GA



01 **SECTION**
1:100



02 **SECTION**
1:100

ISSUED FOR COORDINATION

0 1 2 — 10 AT A1
0 2 4 — 20 AT A3

LOCI

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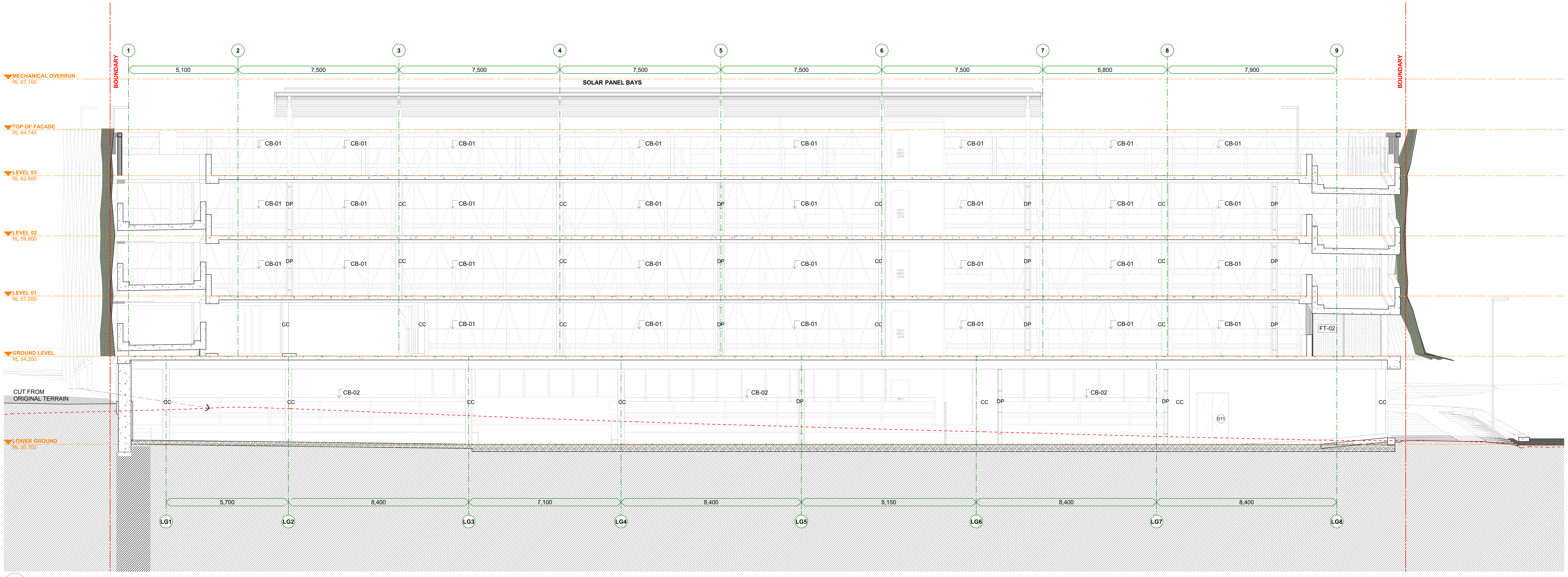
FOR COORDINATION	P3	SC	3/06/2022
FOR COORDINATION	P4	SC	10/06/2022
FOR COORDINATION	P5	SC	24/06/2022

CLIENT
PENRITH CITY COUNCIL
PROJECT
KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT

SCALE @ A1	PROJECT NO.	STAGE	DRAWING NO.	REV
1:100	21.14	CD	A300	P5

SCALE @ A3
DRAWING TITLE
SECTION A + B



01 SECTION
1:100

02 SECTION
1:100

ISSUED FOR COORDINATION

0 1 2 10 AT A1
0 2 4 20 AT A3

LOCI

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FOR COORDINATION	P2	SC	3/06/2022
FOR COORDINATION	P3	SC	10/06/2022
FOR COORDINATION	P4	SC	24/06/2022

CLIENT
PENRITH CITY COUNCIL

PROJECT
KINGSWOOD COMMUTER CARPARK
6 COX AVENUE KINGSWOOD NSW 2747

NORTH POINT

SCALE @ A1	PROJECT NO.	STAGE	DRAWING NO.	REV
1:100	21.14	CD	A301	P4

SCALE @ A3

DRAWING TITLE
SECTION C + D

Appendix B SIDRA Results

INTERSECTION SUMMARY

Site: 101 [Existing Conditions Parker Street and Copeland Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 140 seconds (Site Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Intersection Performance - Hourly Values

Performance Measure	Vehicles		Pedestrians		Persons	
Travel Speed (Average)	33.1	km/h	3.5	km/h	30.0	km/h
Travel Distance (Total)	3123.4	veh-km/h	46.0	ped-km/h	3794.1	pers-km/h
Travel Time (Total)	94.4	veh-h/h	13.1	ped-h/h	126.4	pers-h/h
Desired Speed (Program)	64.3	km/h				
Speed Efficiency	0.51					
Travel Time Index	4.60					
Congestion Coefficient	1.94					
Demand Flows (Total)	3913	veh/h	211	ped/h	4906	pers/h
Percent Heavy Vehicles (Demand)	5.2	%				
Degree of Saturation	0.905		0.102			
Practical Spare Capacity	-0.5	%				
Effective Intersection Capacity	4325	veh/h				
Control Delay (Total)	45.08	veh-h/h	3.25	ped-h/h	57.34	pers-h/h
Control Delay (Average)	41.5	sec	55.5	sec	42.1	sec
Control Delay (Worst Lane)	85.7	sec				
Control Delay (Worst Movement)	86.9	sec	64.3	sec	86.9	sec
Geometric Delay (Average)	1.5	sec				
Stop-Line Delay (Average)	39.9	sec				
Idling Time (Average)	35.3	sec				
Intersection Level of Service (LOS)	LOS C		LOS E			
95% Back of Queue - Vehicles (Worst Lane)	55.6	veh				
95% Back of Queue - Distance (Worst Lane)	400.1	m				
Ave. Queue Storage Ratio (Worst Lane)	0.49					
Total Effective Stops	3366	veh/h	200	ped/h	4239	pers/h
Effective Stop Rate	0.86		0.95		0.86	
Proportion Queued	0.90		0.95		0.90	
Performance Index	317.5		14.2		331.7	
Cost (Total)	4096.81	$/h	361.16	$/h	4457.97	$/h
Fuel Consumption (Total)	430.6	L/h				
Carbon Dioxide (Total)	1024.6	kg/h				
Hydrocarbons (Total)	0.096	kg/h				
Carbon Monoxide (Total)	1.170	kg/h				
NOx (Total)	2.281	kg/h				

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 1.8 %
Number of Iterations: 5 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Main (Timing-Capacity) Iterations: 1.3%   4.1%   0.0%

Intersection Performance - Annual Values

Performance Measure	Vehicles		Pedestrians		Persons	
Demand Flows (Total)	1,878,063	veh/y	101,053	ped/y	2,354,729	pers/y
Delay	21,637	veh-h/y	1,559	ped-h/y	27,523	pers-h/y
Effective Stops	1,615,587	veh/y	95,849	ped/y	2,034,554	pers/y
Travel Distance	1,499,218	veh-km/y	22,100	ped-km/y	1,821,162	pers-km/y
Travel Time	45,332	veh-h/y	6,281	ped-h/y	60,679	pers-h/y
Cost	1,966,466	$/y	173,359	$/y	2,139,825	$/y
Fuel Consumption	206,700	L/y				
Carbon Dioxide	491,802	kg/y				
Hydrocarbons	46	kg/y				

Carbon Monoxide	562	kg/y
NOx	1,095	kg/y

INTERSECTION SUMMARY

Site: 101 [Existing Conditions Parker Street and Copeland Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 150 seconds (Site Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Intersection Performance - Hourly Values

Performance Measure	Vehicles	Pedestrians	Persons
Travel Speed (Average)	33.4 km/h	3.4 km/h	30.4 km/h
Travel Distance (Total)	3365.7 veh-km/h	46.0 ped-km/h	4084.9 pers-km/h
Travel Time (Total)	100.7 veh-h/h	13.4 ped-h/h	134.2 pers-h/h
Desired Speed (Program)	64.7 km/h		
Speed Efficiency	0.52		
Travel Time Index	4.63		
Congestion Coefficient	1.94		
Demand Flows (Total)	4212 veh/h	211 ped/h	5264 pers/h
Percent Heavy Vehicles (Demand)	3.4 %		
Degree of Saturation	0.924	0.110	
Practical Spare Capacity	-2.6 %		
Effective Intersection Capacity	4559 veh/h		
Control Delay (Total)	48.09 veh-h/h	3.55 ped-h/h	61.26 pers-h/h
Control Delay (Average)	41.1 sec	60.8 sec	41.9 sec
Control Delay (Worst Lane)	93.8 sec		
Control Delay (Worst Movement)	96.1 sec	69.3 sec	96.1 sec
Geometric Delay (Average)	1.4 sec		
Stop-Line Delay (Average)	39.7 sec		
Idling Time (Average)	35.1 sec		
Intersection Level of Service (LOS)	LOS C	LOS F	
95% Back of Queue - Vehicles (Worst Lane)	56.3 veh		
95% Back of Queue - Distance (Worst Lane)	406.4 m		
Ave. Queue Storage Ratio (Worst Lane)	0.50		
Total Effective Stops	3574 veh/h	200 ped/h	4489 pers/h
Effective Stop Rate	0.85	0.95	0.85
Proportion Queued	0.87	0.95	0.88
Performance Index	346.4	14.5	360.9
Cost (Total)	4302.11 $/h	369.65 $/h	4671.76 $/h
Fuel Consumption (Total)	430.2 L/h		
Carbon Dioxide (Total)	1018.9 kg/h		
Hydrocarbons (Total)	0.098 kg/h		
Carbon Monoxide (Total)	1.214 kg/h		
NOx (Total)	1.718 kg/h		

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 0.3 %
Number of Iterations: 5 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Main (Timing-Capacity) Iterations: 0.5%   0.5%   0.0%

Intersection Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total)	2,021,558 veh/y	101,053 ped/y	2,526,922 pers/y
Delay	23,081 veh-h/y	1,706 ped-h/y	29,404 pers-h/y
Effective Stops	1,715,456 veh/y	96,211 ped/y	2,154,759 pers/y
Travel Distance	1,615,557 veh-km/y	22,100 ped-km/y	1,960,769 pers-km/y
Travel Time	48,320 veh-h/y	6,429 ped-h/y	64,413 pers-h/y
Cost	2,065,014 $/y	177,431 $/y	2,242,445 $/y
Fuel Consumption	206,510 L/y		
Carbon Dioxide	489,071 kg/y		
Hydrocarbons	47 kg/y		

Carbon Monoxide	583	kg/y
NOx	825	kg/y

INTERSECTION SUMMARY

Site: 101 [Development Conditions Parker Street and Copeland Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 150 seconds (Site Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Intersection Performance - Hourly Values

Performance Measure	Vehicles		Pedestrians		Persons	
Travel Speed (Average)	27.4	km/h	3.4	km/h	25.4	km/h
Travel Distance (Total)	3258.1	veh-km/h	46.0	ped-km/h	3955.8	pers-km/h
Travel Time (Total)	118.7	veh-h/h	13.4	ped-h/h	155.9	pers-h/h
Desired Speed (Program)	64.3	km/h				
Speed Efficiency	0.43					
Travel Time Index	3.63					
Congestion Coefficient	2.34					
Demand Flows (Total)	4067	veh/h	211	ped/h	5091	pers/h
Percent Heavy Vehicles (Demand)	4.9	%				
Degree of Saturation	0.957		0.110			
Practical Spare Capacity	-6.0	%				
Effective Intersection Capacity	4249	veh/h				
Control Delay (Total)	67.35	veh-h/h	3.55	ped-h/h	84.37	pers-h/h
Control Delay (Average)	59.6	sec	60.8	sec	59.7	sec
Control Delay (Worst Lane)	79.3	sec				
Control Delay (Worst Movement)	79.3	sec	69.3	sec	79.3	sec
Geometric Delay (Average)	1.6	sec				
Stop-Line Delay (Average)	58.0	sec				
Idling Time (Average)	52.1	sec				
Intersection Level of Service (LOS)	LOS E		LOS F			
95% Back of Queue - Vehicles (Worst Lane)	69.1	veh				
95% Back of Queue - Distance (Worst Lane)	497.6	m				
Ave. Queue Storage Ratio (Worst Lane)	0.61					
Total Effective Stops	4062	veh/h	200	ped/h	5075	pers/h
Effective Stop Rate	1.00		0.95		1.00	
Proportion Queued	0.97		0.95		0.97	
Performance Index	398.0		14.5		412.5	
Cost (Total)	5031.20	$/h	369.65	$/h	5400.84	$/h
Fuel Consumption (Total)	488.2	L/h				
Carbon Dioxide (Total)	1159.3	kg/h				
Hydrocarbons (Total)	0.114	kg/h				
Carbon Monoxide (Total)	1.305	kg/h				
NOx (Total)	2.476	kg/h				

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 2.8 %
Number of Iterations: 6 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Main (Timing-Capacity) Iterations: 1.7%   2.2%   2.1%

Intersection Performance - Annual Values

Performance Measure	Vehicles		Pedestrians		Persons	
Demand Flows (Total)	1,952,337	veh/y	101,053	ped/y	2,443,857	pers/y
Delay	32,326	veh-h/y	1,706	ped-h/y	40,498	pers-h/y
Effective Stops	1,949,862	veh/y	96,211	ped/y	2,436,045	pers/y
Travel Distance	1,563,910	veh-km/y	22,100	ped-km/y	1,898,792	pers-km/y
Travel Time	56,997	veh-h/y	6,429	ped-h/y	74,825	pers-h/y
Cost	2,414,974	$/y	177,431	$/y	2,592,405	$/y
Fuel Consumption	234,330	L/y				
Carbon Dioxide	556,476	kg/y				
Hydrocarbons	55	kg/y				

Carbon Monoxide	627	kg/y
NOx	1,189	kg/y

INTERSECTION SUMMARY

Site: 101 [Development Conditions Parker Street and Copeland Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 150 seconds (Site Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Intersection Performance - Hourly Values			
Performance Measure	Vehicles	Pedestrians	Persons
Travel Speed (Average)	29.4 km/h	3.4 km/h	27.2 km/h
Travel Distance (Total)	3483.1 veh-km/h	46.0 ped-km/h	4225.8 pers-km/h
Travel Time (Total)	118.4 veh-h/h	13.4 ped-h/h	155.5 pers-h/h
Desired Speed (Program)	64.5 km/h		
Speed Efficiency	0.46		
Travel Time Index	3.96		
Congestion Coefficient	2.19		
Demand Flows (Total)	4348 veh/h	211 ped/h	5429 pers/h
Percent Heavy Vehicles (Demand)	3.6 %		
Degree of Saturation	0.983	0.110	
Practical Spare Capacity	-8.4 %		
Effective Intersection Capacity	4425 veh/h		
Control Delay (Total)	63.77 veh-h/h	3.55 ped-h/h	80.07 pers-h/h
Control Delay (Average)	52.8 sec	60.6 sec	53.1 sec
Control Delay (Worst Lane)	98.2 sec		
Control Delay (Worst Movement)	100.3 sec	69.3 sec	100.3 sec
Geometric Delay (Average)	1.4 sec		
Stop-Line Delay (Average)	51.4 sec		
Idling Time (Average)	46.3 sec		
Intersection Level of Service (LOS)	LOS D	LOS F	
95% Back of Queue - Vehicles (Worst Lane)	70.3 veh		
95% Back of Queue - Distance (Worst Lane)	508.3 m		
Ave. Queue Storage Ratio (Worst Lane)	0.62		
Total Effective Stops	3876 veh/h	200 ped/h	4851 pers/h
Effective Stop Rate	0.89	0.95	0.89
Proportion Queued	0.85	0.95	0.85
Performance Index	390.7	14.5	405.2
Cost (Total)	4971.80 $/h	369.41 $/h	5341.21 $/h
Fuel Consumption (Total)	466.9 L/h		
Carbon Dioxide (Total)	1106.0 kg/h		
Hydrocarbons (Total)	0.108 kg/h		
Carbon Monoxide (Total)	1.288 kg/h		
NOx (Total)	1.898 kg/h		

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 18.0 %
Number of Iterations: 10 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Main (Timing-Capacity) Iterations: 5.8% 3.5% 1.3%

Intersection Performance - Annual Values			
Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total)	2,087,242 veh/y	101,053 ped/y	2,605,744 pers/y
Delay	30,611 veh-h/y	1,702 ped-h/y	38,436 pers-h/y
Effective Stops	1,860,245 veh/y	96,211 ped/y	2,328,505 pers/y
Travel Distance	1,671,885 veh-km/y	22,100 ped-km/y	2,028,362 pers-km/y
Travel Time	56,831 veh-h/y	6,425 ped-h/y	74,622 pers-h/y
Cost	2,386,465 $/y	177,317 $/y	2,563,782 $/y
Fuel Consumption	224,096 L/y		
Carbon Dioxide	530,884 kg/y		
Hydrocarbons	52 kg/y		

Carbon Monoxide	618 kg/y
NOx	911 kg/y

INTERSECTION SUMMARY

Site: 101 [Future Conditions Parker Street and Copeland Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 150 seconds (Site Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Intersection Performance - Hourly Values

Performance Measure	Vehicles	Pedestrians	Persons
Travel Speed (Average)	14.9 km/h	3.4 km/h	14.4 km/h
Travel Distance (Total)	3912.9 veh-km/h	46.0 ped-km/h	4741.5 pers-km/h
Travel Time (Total)	262.7 veh-h/h	13.3 ped-h/h	328.6 pers-h/h
Desired Speed (Program)	64.3 km/h		
Speed Efficiency	0.23		
Travel Time Index	1.46		
Congestion Coefficient	4.32		
Demand Flows (Total)	4899 veh/h	211 ped/h	6089 pers/h
Percent Heavy Vehicles (Demand)	4.8 %		
Degree of Saturation	1.203	0.110	
Practical Spare Capacity	-25.2 %		
Effective Intersection Capacity	4073 veh/h		
Control Delay (Total)	195.34 veh-h/h	3.51 ped-h/h	237.92 pers-h/h
Control Delay (Average)	143.5 sec	60.0 sec	140.7 sec
Control Delay (Worst Lane)	272.2 sec		
Control Delay (Worst Movement)	272.6 sec	69.3 sec	272.6 sec
Geometric Delay (Average)	1.5 sec		
Stop-Line Delay (Average)	142.0 sec		
Idling Time (Average)	138.8 sec		
Intersection Level of Service (LOS)	LOS F	LOS E	
95% Back of Queue - Vehicles (Worst Lane)	154.4 veh		
95% Back of Queue - Distance (Worst Lane)	1111.5 m		
Ave. Queue Storage Ratio (Worst Lane)	1.36		
Total Effective Stops	6158 veh/h	200 ped/h	7590 pers/h
Effective Stop Rate	1.26	0.95	1.25
Proportion Queued	0.91	0.95	0.91
Performance Index	726.0	14.5	740.5
Cost (Total)	10391.01 $/h	368.35 $/h	10759.37 $/h
Fuel Consumption (Total)	750.7 L/h		
Carbon Dioxide (Total)	1779.7 kg/h		
Hydrocarbons (Total)	0.192 kg/h		
Carbon Monoxide (Total)	1.827 kg/h		
NOx (Total)	3.177 kg/h		

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 1.0 %
Number of Iterations: 3 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Main (Timing-Capacity) Iterations: 100.6%   2.9%   1.0%

Intersection Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total)	2,351,495 veh/y	101,053 ped/y	2,922,847 pers/y
Delay	93,765 veh-h/y	1,684 ped-h/y	114,202 pers-h/y
Effective Stops	2,955,814 veh/y	96,211 ped/y	3,643,188 pers/y
Travel Distance	1,878,169 veh-km/y	22,100 ped-km/y	2,275,903 pers-km/y
Travel Time	126,115 veh-h/y	6,406 ped-h/y	157,744 pers-h/y
Cost	4,987,687 $/y	176,810 $/y	5,164,497 $/y
Fuel Consumption	360,337 L/y		
Carbon Dioxide	854,232 kg/y		
Hydrocarbons	92 kg/y		

Carbon Monoxide	877	kg/y
NOx	1,525	kg/y

INTERSECTION SUMMARY

Site: 101 [Future Conditions Parker Street and Copeland Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 150 seconds (Site Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Intersection Performance - Hourly Values			
Performance Measure	**Vehicles**	**Pedestrians**	**Persons**
Travel Speed (Average)	15.7 km/h	3.4 km/h	15.2 km/h
Travel Distance (Total)	4229.5 veh-km/h	46.0 ped-km/h	5121.4 pers-km/h
Travel Time (Total)	270.1 veh-h/h	13.5 ped-h/h	337.6 pers-h/h
Desired Speed (Program)	64.6 km/h		
Speed Efficiency	0.24		
Travel Time Index	1.58		
Congestion Coefficient	4.12		
Demand Flows (Total)	5283 veh/h	211 ped/h	6550 pers/h
Percent Heavy Vehicles (Demand)	3.5 %		
Degree of Saturation	1.197	0.110	
Practical Spare Capacity	-24.8 %		
Effective Intersection Capacity	4415 veh/h		
Control Delay (Total)	193.98 veh-h/h	3.62 ped-h/h	236.40 pers-h/h
Control Delay (Average)	132.2 sec	62.0 sec	129.9 sec
Control Delay (Worst Lane)	245.9 sec		
Control Delay (Worst Movement)	245.8 sec	69.3 sec	245.8 sec
Geometric Delay (Average)	1.4 sec		
Stop-Line Delay (Average)	130.7 sec		
Idling Time (Average)	129.4 sec		
Intersection Level of Service (LOS)	LOS F	LOS F	
95% Back of Queue - Vehicles (Worst Lane)	139.7 veh		
95% Back of Queue - Distance (Worst Lane)	1009.3 m		
Ave. Queue Storage Ratio (Worst Lane)	1.24		
Total Effective Stops	6583 veh/h	200 ped/h	8100 pers/h
Effective Stop Rate	1.25	0.95	1.24
Proportion Queued	0.93	0.95	0.93
Performance Index	771.1	14.6	785.7
Cost (Total)	10676.38 $/h	371.52 $/h	11047.90 $/h
Fuel Consumption (Total)	769.3 L/h		
Carbon Dioxide (Total)	1820.2 kg/h		
Hydrocarbons (Total)	0.196 kg/h		
Carbon Monoxide (Total)	1.922 kg/h		
NOx (Total)	2.831 kg/h		

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 0.0 %
Number of Iterations: 2 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Main (Timing-Capacity) Iterations: 0.0%   72.1%   0.5%

Intersection Performance - Annual Values			
Performance Measure	**Vehicles**	**Pedestrians**	**Persons**
Demand Flows (Total)	2,535,916 veh/y	101,053 ped/y	3,144,152 pers/y
Delay	93,112 veh-h/y	1,739 ped-h/y	113,474 pers-h/y
Effective Stops	3,159,833 veh/y	96,211 ped/y	3,888,011 pers/y
Travel Distance	2,030,151 veh-km/y	22,100 ped-km/y	2,458,281 pers-km/y
Travel Time	129,645 veh-h/y	6,461 ped-h/y	162,035 pers-h/y
Cost	5,124,662 $/y	178,332 $/y	5,302,993 $/y
Fuel Consumption	369,256 L/y		
Carbon Dioxide	873,705 kg/y		
Hydrocarbons	94 kg/y		

Carbon Monoxide	923	kg/y
NOx	1,359	kg/y

MOVEMENT SUMMARY

Site: 101 [Existing Conditions Parker Street and Copeland Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 140 seconds (Site Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Parker Street														
1	L2	43	2	45	4.7	0.480	22.7	LOS B	10.7	80.0	0.77	0.68	0.77	45.8
2	T1	1015	80	1068	7.9	0.480	16.3	LOS B	10.7	80.0	0.77	0.67	0.77	49.5
3	R2	356	17	375	4.8	* 0.886	73.7	LOS F	28.2	205.3	1.00	0.94	1.21	23.8
Approach		1414	99	1488	7.0	0.886	31.0	LOS C	28.2	205.3	0.83	0.74	0.88	38.9
East: Copeland Street														
4	L2	477	12	502	2.5	0.652	37.1	LOS C	26.6	190.0	0.84	0.84	0.84	29.9
5	T1	68	2	72	2.9	0.555	65.3	LOS E	6.9	50.3	0.99	0.79	0.99	26.3
6	R2	30	3	32	10.0	0.555	69.9	LOS E	6.9	50.3	0.99	0.79	0.99	26.2
Approach		575	17	605	3.0	0.652	42.1	LOS C	26.6	190.0	0.87	0.83	0.87	29.0
North: Parker Street														
7	L2	22	4	23	18.2	0.030	28.2	LOS B	0.8	6.7	0.56	0.68	0.56	41.7
8	T1	1474	49	1552	3.3	* 0.905	47.7	LOS D	55.6	400.1	0.98	0.99	1.10	32.0
9	R2	36	18	38	50.0	0.136	36.5	LOS C	1.6	15.5	0.85	0.72	0.85	34.6
Approach		1532	71	1613	4.6	0.905	47.2	LOS D	55.6	400.1	0.97	0.98	1.08	32.2
West: Copeland Street														
10	L2	21	1	22	4.8	0.364	61.3	LOS E	6.3	45.8	0.93	0.79	0.93	27.9
11	T1	107	4	113	3.7	* 0.870	62.8	LOS E	7.5	53.6	0.95	0.84	1.04	26.8
12	R2	68	1	72	1.5	0.870	86.9	LOS F	7.5	53.6	1.00	1.00	1.42	19.9
Approach		196	6	206	3.1	0.870	71.0	LOS F	7.5	53.6	0.96	0.89	1.16	24.4
All Vehicles		3717	193	3913	5.2	0.905	41.5	LOS C	55.6	400.1	0.90	0.86	0.98	33.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance

Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped ped	Dist] m	Prop. Que	Effective Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
South: Parker Street												
P1	Full	50	53	64.3	LOS F	0.2	0.2	0.96	0.96	237.0	224.5	0.95
East: Copeland Street												
P2	Full	50	53	64.3	LOS F	0.2	0.2	0.96	0.96	227.6	212.3	0.93

North: Parker Street												
P3	Full	50	53	64.3	LOS F	0.2	0.2	0.96	0.96	237.3	225.0	0.95
West: Copeland Street												
P4	Full	50	53	29.3	LOS C	0.1	0.1	0.92	0.92	193.2	213.0	1.10
All Pedestrians		200	211	55.5	LOS E	0.2	0.2	0.95	0.95	223.8	218.7	0.98

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Existing Conditions Parker Street and Copeland Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 150 seconds (Site Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Parker Street														
1	L2	17	1	18	5.9	0.544	22.5	LOS B	17.6	127.9	0.74	0.66	0.74	46.1
2	T1	1420	61	1495	4.3	0.544	16.1	LOS B	17.6	127.9	0.74	0.66	0.74	49.9
3	R2	410	11	432	2.7	* 0.912	56.6	LOS E	26.6	190.8	1.00	0.95	1.23	28.1
Approach		1847	73	1944	4.0	0.912	25.1	LOS B	26.6	190.8	0.80	0.72	0.85	42.5
East: Copeland Street														
4	L2	442	4	465	0.9	0.536	32.3	LOS C	23.1	162.7	0.74	0.80	0.74	31.5
5	T1	78	2	82	2.6	* 0.924	91.6	LOS F	14.0	99.8	1.00	1.09	1.43	22.0
6	R2	76	1	80	1.3	0.924	96.1	LOS F	14.0	99.8	1.00	1.09	1.43	21.9
Approach		596	7	627	1.2	0.924	48.2	LOS D	23.1	162.7	0.81	0.87	0.92	27.7
North: Parker Street														
7	L2	21	2	22	9.5	0.030	33.6	LOS C	0.9	6.9	0.60	0.69	0.60	40.5
8	T1	1356	50	1427	3.7	* 0.915	57.2	LOS E	56.3	406.4	1.00	1.02	1.14	28.8
9	R2	29	2	31	6.9	0.109	36.7	LOS C	1.1	7.9	0.89	0.72	0.89	39.3
Approach		1406	54	1480	3.8	0.915	56.4	LOS D	56.3	406.4	0.99	1.01	1.13	29.2
West: Copeland Street														
10	L2	15	0	16	0.0	0.198	63.0	LOS E	3.1	21.6	0.91	0.76	0.91	27.5
11	T1	103	2	108	1.9	0.473	64.0	LOS E	7.1	50.6	0.95	0.77	0.95	26.5
12	R2	34	1	36	2.9	0.473	71.5	LOS F	7.1	50.6	0.98	0.78	0.98	22.6
Approach		152	3	160	2.0	0.473	65.6	LOS E	7.1	50.6	0.95	0.77	0.95	25.8
All Vehicles		4001	137	4212	3.4	0.924	41.1	LOS C	56.3	406.4	0.87	0.85	0.96	33.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance

Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped ped	Dist] m	Prop. Que	Effective Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
South: Parker Street												
P1	Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	242.0	224.5	0.93
East: Copeland Street												
P2	Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	232.6	212.3	0.91

North: Parker Street											
P3 Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	242.3	225.0	0.93
West: Copeland Street											
P4 Full	50	53	35.3	LOS D	0.1	0.1	0.92	0.92	199.2	213.0	1.07
All Pedestrians	200	211	60.8	LOS F	0.2	0.2	0.95	0.95	229.0	218.7	0.95

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Development Conditions Parker Street and Copeland Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 150 seconds (Site Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	INPUT VOLUMES HV] veh/h	DEMAND FLOWS [Total veh/h	DEMAND FLOWS HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	95% BACK OF QUEUE Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Parker Street														
1	L2	45	3	47	6.7	0.861	55.1	LOS D	21.4	159.9	1.00	0.99	1.14	29.8
2	T1	1036	82	1091	7.9	* 0.861	48.8	LOS D	21.4	159.9	1.00	0.99	1.14	31.5
3	R2	380	18	400	4.7	* 0.953	79.3	LOS F	27.2	198.1	1.00	1.04	1.35	22.8
Approach		1461	103	1538	7.0	0.953	56.9	LOS E	27.2	198.1	1.00	1.00	1.20	28.6
East: Copeland Street														
4	L2	488	13	514	2.7	0.643	37.5	LOS C	28.4	203.5	0.83	0.83	0.83	29.7
5	T1	71	3	75	4.2	0.631	71.8	LOS F	7.9	58.5	1.00	0.81	1.03	25.1
6	R2	32	4	34	12.5	0.631	76.5	LOS F	7.9	58.5	1.00	0.81	1.03	25.0
Approach		591	20	622	3.4	0.643	43.8	LOS D	28.4	203.5	0.86	0.83	0.86	28.6
North: Parker Street														
7	L2	45	5	47	11.1	0.060	31.1	LOS C	1.9	14.4	0.58	0.71	0.58	41.4
8	T1	1504	50	1583	3.3	* 0.957	69.2	LOS E	69.1	497.6	1.00	1.10	1.23	25.7
9	R2	52	2	55	3.8	0.067	30.2	LOS C	2.2	15.7	0.58	0.71	0.58	42.6
Approach		1601	57	1685	3.6	0.957	66.8	LOS E	69.1	497.6	0.97	1.08	1.19	26.5
West: Copeland Street														
10	L2	23	2	24	8.7	0.312	55.7	LOS D	4.7	34.8	0.94	0.76	0.94	29.0
11	T1	117	5	123	4.3	* 0.745	63.5	LOS E	10.5	75.5	0.97	0.82	1.03	26.6
12	R2	71	2	75	2.8	0.745	78.5	LOS F	10.5	75.5	1.00	0.88	1.11	21.3
Approach		211	9	222	4.3	0.745	67.7	LOS E	10.5	75.5	0.98	0.83	1.05	25.1
All Vehicles		3864	189	4067	4.9	0.957	59.6	LOS E	69.1	497.6	0.97	1.00	1.14	27.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance

Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped ped	AVERAGE BACK OF QUEUE Dist] m	Prop. Que	Effective Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
South: Parker Street												
P1	Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	242.0	224.5	0.93
East: Copeland Street												
P2	Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	232.6	212.3	0.91

North: Parker Street											
P3 Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	242.3	225.0	0.93
West: Copeland Street											
P4 Full	50	53	35.3	LOS D	0.1	0.1	0.92	0.92	199.2	213.0	1.07
All Pedestrians	200	211	60.8	LOS F	0.2	0.2	0.95	0.95	229.0	218.7	0.95

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Development Conditions Parker Street and Copeland Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 150 seconds (Site Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Parker Street														
1	L2	19	2	20	10.5	0.508	18.5	LOS B	13.5	98.4	0.68	0.61	0.68	48.2
2	T1	1450	63	1526	4.3	0.508	12.0	LOS A	13.5	98.4	0.68	0.60	0.68	53.8
3	R2	419	12	441	2.9	* 0.982	81.3	LOS F	32.1	230.2	1.00	1.02	1.43	22.5
Approach		1888	77	1987	4.1	0.982	27.4	LOS B	32.1	230.2	0.75	0.70	0.85	41.1
East: Copeland Street														
4	L2	458	5	482	1.1	0.535	30.5	LOS C	23.3	164.3	0.72	0.79	0.72	32.2
5	T1	87	3	92	3.4	* 0.944	95.8	LOS F	17.7	126.8	1.00	1.12	1.46	21.4
6	R2	100	2	105	2.0	0.944	100.3	LOS F	17.7	126.8	1.00	1.12	1.46	21.4
Approach		645	10	679	1.6	0.944	50.1	LOS D	23.3	164.3	0.80	0.89	0.94	27.4
North: Parker Street														
7	L2	23	3	24	13.0	0.035	35.7	LOS C	1.0	8.1	0.63	0.69	0.63	39.2
8	T1	1385	52	1458	3.8	* 0.983	87.6	LOS F	70.3	508.3	1.00	1.18	1.34	22.0
9	R2	31	3	33	9.7	0.159	71.3	LOS F	2.2	16.5	0.93	0.73	0.93	28.5
Approach		1439	58	1515	4.0	0.983	86.4	LOS F	70.3	508.3	0.99	1.16	1.32	22.3
West: Copeland Street														
10	L2	16	0	17	0.0	0.173	57.2	LOS E	3.0	21.3	0.88	0.74	0.88	28.7
11	T1	107	3	113	2.8	0.413	59.3	LOS E	7.2	52.2	0.92	0.76	0.92	27.5
12	R2	36	2	38	5.6	0.413	67.3	LOS E	7.2	52.2	0.95	0.77	0.95	23.4
Approach		159	5	167	3.1	0.413	60.9	LOS E	7.2	52.2	0.92	0.76	0.92	26.7
All Vehicles		4131	150	4348	3.6	0.983	52.8	LOS D	70.3	508.3	0.85	0.89	1.03	29.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance

Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped ped	Dist] m	Prop. Que	Effective Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
South: Parker Street												
P1	Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	242.0	224.5	0.93
East: Copeland Street												
P2	Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	232.6	212.3	0.91

North: Parker Street												
P3	Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	242.3	225.0	0.93
West: Copeland Street												
P4	Full	50	53	34.8	LOS D	0.1	0.1	0.92	0.92	198.6	213.0	1.07
All Pedestrians		200	211	60.6	LOS F	0.2	0.2	0.95	0.95	228.9	218.7	0.96

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Future Conditions Parker Street and Copeland Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 150 seconds (Site Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Parker Street														
1	L2	54	3	57	5.6	0.524	22.3	LOS B	15.4	114.6	0.74	0.67	0.74	46.0
2	T1	1263	100	1329	7.9	0.524	15.9	LOS B	15.4	114.6	0.74	0.66	0.74	49.9
3	R2	460	22	484	4.8	* 1.198	261.9	LOS F	75.5	550.3	1.00	1.33	2.25	8.9
Approach		1777	125	1871	7.0	1.198	79.8	LOS F	75.5	550.3	0.81	0.83	1.13	22.7
East: Copeland Street														
4	L2	594	15	625	2.5	0.749	38.2	LOS C	36.6	262.0	0.88	0.86	0.88	29.5
5	T1	86	3	91	3.5	0.703	71.9	LOS F	9.6	70.7	1.00	0.86	1.08	25.1
6	R2	38	4	40	10.5	0.703	76.5	LOS F	9.6	70.7	1.00	0.86	1.08	25.0
Approach		718	22	756	3.1	0.749	44.3	LOS D	36.6	262.0	0.90	0.86	0.91	28.4
North: Parker Street														
7	L2	49	5	52	10.2	0.068	32.9	LOS C	2.1	16.2	0.61	0.71	0.61	40.7
8	T1	1833	61	1929	3.3	* 1.201	248.7	LOS F	154.4	1111.5	1.00	1.87	2.18	9.5
9	R2	25	2	26	8.0	0.104	41.3	LOS C	1.2	8.8	0.90	0.71	0.90	37.3
Approach		1907	68	2007	3.6	1.201	240.4	LOS F	154.4	1111.5	0.99	1.83	2.13	9.8
West: Copeland Street														
10	L2	27	2	28	7.4	0.503	69.4	LOS E	10.7	77.5	0.95	0.83	0.95	26.3
11	T1	139	5	146	3.6	* 1.203	77.4	LOS F	15.5	110.7	0.95	0.87	1.04	24.2
12	R2	86	2	91	2.3	1.203	272.6	LOS F	15.5	110.7	1.00	1.47	2.47	8.3
Approach		252	9	265	3.6	1.203	143.2	LOS F	15.5	110.7	0.97	1.07	1.52	15.7
All Vehicles		4654	224	4899	4.8	1.203	143.5	LOS F	154.4	1111.5	0.91	1.26	1.53	14.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance

Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped ped	Dist] m	Prop. Que	Effective Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
South: Parker Street												
P1	Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	242.0	224.5	0.93
East: Copeland Street												
P2	Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	232.6	212.3	0.91

North: Parker Street											
P3 Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	242.3	225.0	0.93
West: Copeland Street											
P4 Full	50	53	32.1	LOS D	0.1	0.1	0.92	0.92	196.0	213.0	1.09
All Pedestrians	200	211	60.0	LOS E	0.2	0.2	0.95	0.95	228.2	218.7	0.96

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Future Conditions Parker Street and Copeland Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 150 seconds (Site Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Vehicle Movement Performance															
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Parker Street															
1	L2	22	2	23	9.1	0.781	30.5	LOS C	31.2	226.5	0.91	0.82	0.91	40.2
2	T1	1766	76	1859	4.3	0.781	23.6	LOS B	31.2	226.5	0.90	0.80	0.90	44.0
3	R2	511	14	538	2.7	* 1.197	235.3	LOS F	68.7	492.5	1.00	1.32	2.23	8.9
Approach		2299	92	2420	4.0	1.197	70.7	LOS F	68.7	492.5	0.92	0.92	1.19	23.5
East: Copeland Street															
4	L2	556	5	585	0.9	0.648	32.7	LOS C	30.7	216.7	0.79	0.83	0.79	31.3
5	T1	104	3	109	2.9	* 1.173	239.4	LOS F	34.2	244.2	1.00	1.63	2.24	11.3
6	R2	117	2	123	1.7	1.173	244.0	LOS F	34.2	244.2	1.00	1.63	2.24	11.3
Approach		777	10	818	1.3	1.173	92.2	LOS F	34.2	244.2	0.85	1.06	1.20	19.5
North: Parker Street															
7	L2	27	3	28	11.1	0.041	35.8	LOS C	1.2	9.4	0.63	0.70	0.63	39.4
8	T1	1687	63	1776	3.7	* 1.196	245.8	LOS F	139.7	1009.3	1.00	1.85	2.17	9.6
9	R2	37	3	39	8.1	0.130	35.8	LOS C	1.3	9.6	0.88	0.73	0.88	39.4
Approach		1751	69	1843	3.9	1.196	238.1	LOS F	139.7	1009.3	0.99	1.81	2.12	9.9
West: Copeland Street															
10	L2	19	0	20	0.0	0.207	63.8	LOS E	4.1	29.2	0.88	0.77	0.88	27.3
11	T1	129	3	136	2.3	0.494	62.4	LOS E	8.8	63.0	0.93	0.78	0.93	26.9
12	R2	44	2	46	4.5	0.494	68.2	LOS E	8.8	63.0	0.96	0.79	0.96	23.2
Approach		192	5	202	2.6	0.494	63.8	LOS E	8.8	63.0	0.93	0.78	0.93	26.1
All Vehicles		5019	176	5283	3.5	1.197	132.2	LOS F	139.7	1009.3	0.93	1.25	1.51	15.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance												
Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped ped	Dist] m	Prop. Que	Effective Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
South: Parker Street												
P1	Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	242.0	224.5	0.93
East: Copeland Street												
P2	Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	232.6	212.3	0.91

North: Parker Street											
P3 Full	50	53	69.3	LOS F	0.2	0.2	0.96	0.96	242.3	225.0	0.93
West: Copeland Street											
P4 Full	50	53	40.0	LOS D	0.2	0.2	0.92	0.92	203.8	213.0	1.04
All Pedestrians	200	211	62.0	LOS F	0.2	0.2	0.95	0.95	230.2	218.7	0.95

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

INTERSECTION SUMMARY

Site: 101 [Existing Conditions Copeland Street and Phillip Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	45.1 km/h	45.1 km/h
Travel Distance (Total)	942.8 veh-km/h	1131.3 pers-km/h
Travel Time (Total)	20.9 veh-h/h	25.1 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.90	
Travel Time Index	8.90	
Congestion Coefficient	1.11	
Demand Flows (Total)	1149 veh/h	1379 pers/h
Percent Heavy Vehicles (Demand)	4.6 %	
Degree of Saturation	0.597	
Practical Spare Capacity	42.4 %	
Effective Intersection Capacity	1926 veh/h	
Control Delay (Total)	1.82 veh-h/h	2.18 pers-h/h
Control Delay (Average)	5.7 sec	5.7 sec
Control Delay (Worst Lane)	8.6 sec	
Control Delay (Worst Movement)	11.4 sec	11.4 sec
Geometric Delay (Average)	4.1 sec	
Stop-Line Delay (Average)	1.6 sec	
Idling Time (Average)	0.1 sec	
Intersection Level of Service (LOS)	LOS A	
95% Back of Queue - Vehicles (Worst Lane)	5.6 veh	
95% Back of Queue - Distance (Worst Lane)	40.1 m	
Ave. Queue Storage Ratio (Worst Lane)	0.03	
Total Effective Stops	623 veh/h	748 pers/h
Effective Stop Rate	0.54	0.54
Proportion Queued	0.46	0.46
Performance Index	44.2	44.2
Cost (Total)	894.60 $/h	894.60 $/h
Fuel Consumption (Total)	89.6 L/h	
Carbon Dioxide (Total)	213.2 kg/h	
Hydrocarbons (Total)	0.016 kg/h	
Carbon Monoxide (Total)	0.175 kg/h	
NOx (Total)	0.405 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 2.4 %
Number of Iterations: 6 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 2.7% 1.4% 0.7%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	551,747 veh/y	662,097 pers/y
Delay	872 veh-h/y	1,046 pers-h/y
Effective Stops	299,162 veh/y	358,994 pers/y
Travel Distance	452,533 veh-km/y	543,040 pers-km/y
Travel Time	10,042 veh-h/y	12,050 pers-h/y
Cost	429,409 $/y	429,409 $/y
Fuel Consumption	43,029 L/y	
Carbon Dioxide	102,354 kg/y	
Hydrocarbons	8 kg/y	
Carbon Monoxide	84 kg/y	

NOx	194 kg/y

INTERSECTION SUMMARY

Site: 101 [Existing Conditions Copeland Street and Phillip Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	46.2 km/h	46.2 km/h
Travel Distance (Total)	1009.8 veh-km/h	1211.7 pers-km/h
Travel Time (Total)	21.9 veh-h/h	26.3 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.92	
Travel Time Index	9.15	
Congestion Coefficient	1.08	
Demand Flows (Total)	1182 veh/h	1419 pers/h
Percent Heavy Vehicles (Demand)	2.1 %	
Degree of Saturation	0.475	
Practical Spare Capacity	79.0 %	
Effective Intersection Capacity	2489 veh/h	
Control Delay (Total)	1.45 veh-h/h	1.74 pers-h/h
Control Delay (Average)	4.4 sec	4.4 sec
Control Delay (Worst Lane)	9.9 sec	
Control Delay (Worst Movement)	11.4 sec	11.4 sec
Geometric Delay (Average)	3.8 sec	
Stop-Line Delay (Average)	0.6 sec	
Idling Time (Average)	0.1 sec	
Intersection Level of Service (LOS)	LOS A	
95% Back of Queue - Vehicles (Worst Lane)	4.3 veh	
95% Back of Queue - Distance (Worst Lane)	30.1 m	
Ave. Queue Storage Ratio (Worst Lane)	0.02	
Total Effective Stops	520 veh/h	625 pers/h
Effective Stop Rate	0.44	0.44
Proportion Queued	0.25	0.25
Performance Index	40.1	40.1
Cost (Total)	913.43 $/h	913.43 $/h
Fuel Consumption (Total)	84.0 L/h	
Carbon Dioxide (Total)	198.5 kg/h	
Hydrocarbons (Total)	0.014 kg/h	
Carbon Monoxide (Total)	0.161 kg/h	
NOx (Total)	0.217 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 1.3 %
Number of Iterations: 5 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 2.0% 1.3% 0.6%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	567,411 veh/y	680,893 pers/y
Delay	697 veh-h/y	836 pers-h/y
Effective Stops	249,823 veh/y	299,788 pers/y
Travel Distance	484,695 veh-km/y	581,634 pers-km/y
Travel Time	10,500 veh-h/y	12,600 pers-h/y
Cost	438,447 $/y	438,447 $/y
Fuel Consumption	40,301 L/y	
Carbon Dioxide	95,293 kg/y	
Hydrocarbons	7 kg/y	
Carbon Monoxide	77 kg/y	

NOx	104 kg/y

INTERSECTION SUMMARY

Site: 101 [Development Conditions Copeland Street and Phillip Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Intersection Performance - Hourly Values

Performance Measure	Vehicles	Persons
Travel Speed (Average)	44.7 km/h	44.7 km/h
Travel Distance (Total)	1006.6 veh-km/h	1207.9 pers-km/h
Travel Time (Total)	22.5 veh-h/h	27.0 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.89	
Travel Time Index	8.82	
Congestion Coefficient	1.12	
Demand Flows (Total)	1239 veh/h	1487 pers/h
Percent Heavy Vehicles (Demand)	5.1 %	
Degree of Saturation	0.654	
Practical Spare Capacity	30.0 %	
Effective Intersection Capacity	1894 veh/h	
Control Delay (Total)	2.20 veh-h/h	2.64 pers-h/h
Control Delay (Average)	6.4 sec	6.4 sec
Control Delay (Worst Lane)	9.1 sec	
Control Delay (Worst Movement)	12.0 sec	12.0 sec
Geometric Delay (Average)	4.2 sec	
Stop-Line Delay (Average)	2.2 sec	
Idling Time (Average)	0.2 sec	
Intersection Level of Service (LOS)	LOS A	
95% Back of Queue - Vehicles (Worst Lane)	6.6 veh	
95% Back of Queue - Distance (Worst Lane)	47.7 m	
Ave. Queue Storage Ratio (Worst Lane)	0.04	
Total Effective Stops	728 veh/h	873 pers/h
Effective Stop Rate	0.59	0.59
Proportion Queued	0.52	0.52
Performance Index	50.7	50.7
Cost (Total)	967.19 $/h	967.19 $/h
Fuel Consumption (Total)	98.4 L/h	
Carbon Dioxide (Total)	234.3 kg/h	
Hydrocarbons (Total)	0.017 kg/h	
Carbon Monoxide (Total)	0.193 kg/h	
NOx (Total)	0.478 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 2.9 %
Number of Iterations: 6 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 3.4% 1.8% 0.9%

Intersection Performance - Annual Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	594,695 veh/y	713,634 pers/y
Delay	1,058 veh-h/y	1,269 pers-h/y
Effective Stops	349,268 veh/y	419,121 pers/y
Travel Distance	483,150 veh-km/y	579,780 pers-km/y
Travel Time	10,809 veh-h/y	12,971 pers-h/y
Cost	464,250 $/y	464,250 $/y
Fuel Consumption	47,224 L/y	
Carbon Dioxide	112,443 kg/y	
Hydrocarbons	8 kg/y	
Carbon Monoxide	93 kg/y	

NOx	229 kg/y

INTERSECTION SUMMARY

Site: 101 [Development Conditions Copeland Street and Phillip Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Intersection Performance - Hourly Values

Performance Measure	Vehicles	Persons
Travel Speed (Average)	45.9 km/h	45.9 km/h
Travel Distance (Total)	1065.0 veh-km/h	1278.0 pers-km/h
Travel Time (Total)	23.2 veh-h/h	27.8 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.92	
Travel Time Index	9.10	
Congestion Coefficient	1.09	
Demand Flows (Total)	1255 veh/h	1506 pers/h
Percent Heavy Vehicles (Demand)	2.6 %	
Degree of Saturation	0.511	
Practical Spare Capacity	66.3 %	
Effective Intersection Capacity	2455 veh/h	
Control Delay (Total)	1.61 veh-h/h	1.93 pers-h/h
Control Delay (Average)	4.6 sec	4.6 sec
Control Delay (Worst Lane)	10.2 sec	
Control Delay (Worst Movement)	11.7 sec	11.7 sec
Geometric Delay (Average)	3.8 sec	
Stop-Line Delay (Average)	0.8 sec	
Idling Time (Average)	0.2 sec	
Intersection Level of Service (LOS)	LOS A	
95% Back of Queue - Vehicles (Worst Lane)	4.8 veh	
95% Back of Queue - Distance (Worst Lane)	34.1 m	
Ave. Queue Storage Ratio (Worst Lane)	0.03	
Total Effective Stops	568 veh/h	681 pers/h
Effective Stop Rate	0.45	0.45
Proportion Queued	0.29	0.29
Performance Index	43.6	43.6
Cost (Total)	971.64 $/h	971.64 $/h
Fuel Consumption (Total)	90.6 L/h	
Carbon Dioxide (Total)	214.5 kg/h	
Hydrocarbons (Total)	0.016 kg/h	
Carbon Monoxide (Total)	0.174 kg/h	
NOx (Total)	0.267 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 1.7 %
Number of Iterations: 5 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 2.5% 1.6% 0.8%

Intersection Performance - Annual Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	602,274 veh/y	722,729 pers/y
Delay	772 veh-h/y	927 pers-h/y
Effective Stops	272,555 veh/y	327,067 pers/y
Travel Distance	511,207 veh-km/y	613,448 pers-km/y
Travel Time	11,127 veh-h/y	13,353 pers-h/y
Cost	466,387 $/y	466,387 $/y
Fuel Consumption	43,492 L/y	
Carbon Dioxide	102,950 kg/y	
Hydrocarbons	7 kg/y	
Carbon Monoxide	84 kg/y	

NOx	128 kg/y

INTERSECTION SUMMARY

Site: 101 [Future Conditions Copeland Street and Phillip Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	42.9 km/h	42.9 km/h
Travel Distance (Total)	1212.9 veh-km/h	1455.4 pers-km/h
Travel Time (Total)	28.3 veh-h/h	34.0 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.86	
Travel Time Index	8.41	
Congestion Coefficient	1.17	
Demand Flows (Total)	1489 veh/h	1787 pers/h
Percent Heavy Vehicles (Demand)	4.7 %	
Degree of Saturation	0.820	
Practical Spare Capacity	3.6 %	
Effective Intersection Capacity	1816 veh/h	
Control Delay (Total)	3.87 veh-h/h	4.64 pers-h/h
Control Delay (Average)	9.3 sec	9.3 sec
Control Delay (Worst Lane)	12.7 sec	
Control Delay (Worst Movement)	15.5 sec	15.5 sec
Geometric Delay (Average)	4.2 sec	
Stop-Line Delay (Average)	5.2 sec	
Idling Time (Average)	1.6 sec	
Intersection Level of Service (LOS)	LOS A	
95% Back of Queue - Vehicles (Worst Lane)	14.6 veh	
95% Back of Queue - Distance (Worst Lane)	105.2 m	
Ave. Queue Storage Ratio (Worst Lane)	0.08	
Total Effective Stops	1065 veh/h	1278 pers/h
Effective Stop Rate	0.71	0.71
Proportion Queued	0.68	0.68
Performance Index	79.0	79.0
Cost (Total)	1207.66 $/h	1207.66 $/h
Fuel Consumption (Total)	120.2 L/h	
Carbon Dioxide (Total)	286.0 kg/h	
Hydrocarbons (Total)	0.022 kg/h	
Carbon Monoxide (Total)	0.236 kg/h	
NOx (Total)	0.555 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 4.7 %
Number of Iterations: 7 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 3.6% 1.8% 0.9%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	714,948 veh/y	857,937 pers/y
Delay	1,856 veh-h/y	2,227 pers-h/y
Effective Stops	511,059 veh/y	613,270 pers/y
Travel Distance	582,171 veh-km/y	698,605 pers-km/y
Travel Time	13,582 veh-h/y	16,298 pers-h/y
Cost	579,679 $/y	579,679 $/y
Fuel Consumption	57,710 L/y	
Carbon Dioxide	137,278 kg/y	
Hydrocarbons	10 kg/y	
Carbon Monoxide	113 kg/y	

NOx	267 kg/y

INTERSECTION SUMMARY

Site: 101 [Future Conditions Copeland Street and Phillip Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	45.6 km/h	45.6 km/h
Travel Distance (Total)	1286.9 veh-km/h	1544.3 pers-km/h
Travel Time (Total)	28.2 veh-h/h	33.8 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.91	
Travel Time Index	9.03	
Congestion Coefficient	1.10	
Demand Flows (Total)	1514 veh/h	1816 pers/h
Percent Heavy Vehicles (Demand)	1.9 %	
Degree of Saturation	0.616	
Practical Spare Capacity	38.0 %	
Effective Intersection Capacity	2457 veh/h	
Control Delay (Total)	2.06 veh-h/h	2.47 pers-h/h
Control Delay (Average)	4.9 sec	4.9 sec
Control Delay (Worst Lane)	11.6 sec	
Control Delay (Worst Movement)	13.0 sec	13.0 sec
Geometric Delay (Average)	3.8 sec	
Stop-Line Delay (Average)	1.1 sec	
Idling Time (Average)	0.3 sec	
Intersection Level of Service (LOS)	LOS A	
95% Back of Queue - Vehicles (Worst Lane)	7.0 veh	
95% Back of Queue - Distance (Worst Lane)	49.2 m	
Ave. Queue Storage Ratio (Worst Lane)	0.04	
Total Effective Stops	702 veh/h	842 pers/h
Effective Stop Rate	0.46	0.46
Proportion Queued	0.37	0.37
Performance Index	56.8	56.8
Cost (Total)	1174.80 $/h	1174.80 $/h
Fuel Consumption (Total)	107.1 L/h	
Carbon Dioxide (Total)	253.2 kg/h	
Hydrocarbons (Total)	0.018 kg/h	
Carbon Monoxide (Total)	0.206 kg/h	
NOx (Total)	0.257 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 2.3 %
Number of Iterations: 6 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 2.8%   1.5%   0.7%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	726,568 veh/y	871,882 pers/y
Delay	987 veh-h/y	1,184 pers-h/y
Effective Stops	336,827 veh/y	404,192 pers/y
Travel Distance	617,720 veh-km/y	741,264 pers-km/y
Travel Time	13,533 veh-h/y	16,239 pers-h/y
Cost	563,903 $/y	563,903 $/y
Fuel Consumption	51,423 L/y	
Carbon Dioxide	121,527 kg/y	
Hydrocarbons	9 kg/y	
Carbon Monoxide	99 kg/y	

NOx	124 kg/y

MOVEMENT SUMMARY

Site: 101 [Existing Conditions Copeland Street and Phillip Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Phillip Street														
1	L2	25	3	26	12.0	0.071	8.2	LOS A	0.3	2.7	0.64	0.72	0.64	40.1
2	T1	8	1	8	12.5	0.071	8.0	LOS A	0.3	2.7	0.64	0.72	0.64	40.9
3	R2	5	1	5	20.0	0.071	11.4	LOS A	0.3	2.7	0.64	0.72	0.64	42.1
Approach		38	5	40	13.2	0.071	8.6	LOS A	0.3	2.7	0.64	0.72	0.64	40.6
East: Copeland Street														
4	L2	36	2	38	5.6	0.597	5.9	LOS A	5.6	40.1	0.60	0.57	0.60	43.2
5	T1	494	15	520	3.0	0.597	5.7	LOS A	5.6	40.1	0.60	0.57	0.60	45.3
6	R2	22	0	23	0.0	0.597	8.7	LOS A	5.6	40.1	0.60	0.57	0.60	45.0
Approach		552	17	581	3.1	0.597	5.9	LOS A	5.6	40.1	0.60	0.57	0.60	45.2
North: Phillip Street														
7	L2	22	0	23	0.0	0.118	6.6	LOS A	0.7	5.2	0.56	0.64	0.56	43.6
8	T1	23	1	24	4.3	0.118	6.6	LOS A	0.7	5.2	0.56	0.64	0.56	41.4
9	R2	44	2	46	4.5	0.118	9.7	LOS A	0.7	5.2	0.56	0.64	0.56	43.1
Approach		89	3	94	3.4	0.118	8.2	LOS A	0.7	5.2	0.56	0.64	0.56	42.9
West: Copeland Street														
10	L2	108	4	114	3.7	0.366	4.2	LOS A	2.7	20.0	0.22	0.47	0.22	44.8
11	T1	236	20	248	8.5	0.366	4.2	LOS A	2.7	20.0	0.22	0.47	0.22	46.3
12	R2	69	1	73	1.4	0.366	7.2	LOS A	2.7	20.0	0.22	0.47	0.22	44.0
Approach		413	25	435	6.1	0.366	4.7	LOS A	2.7	20.0	0.22	0.47	0.22	45.6
All Vehicles		1092	50	1149	4.6	0.597	5.7	LOS A	5.6	40.1	0.46	0.54	0.46	45.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Existing Conditions Copeland Street and Phillip Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Phillip Street														
1	L2	42	1	44	2.4	0.098	7.8	LOS A	0.5	3.3	0.60	0.71	0.60	40.7
2	T1	13	0	14	0.0	0.098	7.5	LOS A	0.5	3.3	0.60	0.71	0.60	41.4
3	R2	6	0	6	0.0	0.098	10.6	LOS A	0.5	3.3	0.60	0.71	0.60	42.9
Approach		61	1	64	1.6	0.098	8.0	LOS A	0.5	3.3	0.60	0.71	0.60	41.1
East: Copeland Street														
4	L2	30	0	32	0.0	0.475	4.2	LOS A	4.3	30.1	0.27	0.42	0.27	44.6
5	T1	530	6	558	1.1	0.475	4.1	LOS A	4.3	30.1	0.27	0.42	0.27	46.5
6	R2	1	0	1	0.0	0.475	7.1	LOS A	4.3	30.1	0.27	0.42	0.27	46.1
Approach		561	6	591	1.1	0.475	4.1	LOS A	4.3	30.1	0.27	0.42	0.27	46.4
North: Phillip Street														
7	L2	8	0	8	0.0	0.049	7.7	LOS A	0.3	2.3	0.63	0.65	0.63	42.7
8	T1	5	1	5	20.0	0.049	8.4	LOS A	0.3	2.3	0.63	0.65	0.63	39.7
9	R2	18	3	19	16.7	0.049	11.4	LOS A	0.3	2.3	0.63	0.65	0.63	41.8
Approach		31	4	33	12.9	0.049	9.9	LOS A	0.3	2.3	0.63	0.65	0.63	41.8
West: Copeland Street														
10	L2	26	1	27	3.8	0.377	3.9	LOS A	3.1	22.0	0.16	0.42	0.16	45.2
11	T1	431	11	454	2.6	0.377	3.9	LOS A	3.1	22.0	0.16	0.42	0.16	46.8
12	R2	13	1	14	7.7	0.377	7.0	LOS A	3.1	22.0	0.16	0.42	0.16	44.0
Approach		470	13	495	2.8	0.377	4.0	LOS A	3.1	22.0	0.16	0.42	0.16	46.7
All Vehicles		1123	24	1182	2.1	0.475	4.4	LOS A	4.3	30.1	0.25	0.44	0.25	46.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Development Conditions Copeland Street and Phillip Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Phillip Street														
1	L2	27	4	28	14.8	0.088	8.5	LOS A	0.4	3.6	0.67	0.75	0.67	39.7
2	T1	10	2	11	20.0	0.088	8.5	LOS A	0.4	3.6	0.67	0.75	0.67	40.4
3	R2	7	2	7	28.6	0.088	12.0	LOS A	0.4	3.6	0.67	0.75	0.67	41.7
Approach		44	8	46	18.2	0.088	9.1	LOS A	0.4	3.6	0.67	0.75	0.67	40.2
East: Copeland Street														
4	L2	38	3	40	7.9	0.654	7.2	LOS A	6.6	47.7	0.72	0.65	0.73	42.7
5	T1	505	16	532	3.2	0.654	6.9	LOS A	6.6	47.7	0.72	0.65	0.73	44.9
6	R2	23	0	24	0.0	0.654	9.8	LOS A	6.6	47.7	0.72	0.65	0.73	44.6
Approach		566	19	596	3.4	0.654	7.0	LOS A	6.6	47.7	0.72	0.65	0.73	44.8
North: Phillip Street														
7	L2	23	0	24	0.0	0.135	7.2	LOS A	0.8	6.2	0.62	0.67	0.62	43.2
8	T1	25	2	26	8.0	0.135	7.4	LOS A	0.8	6.2	0.62	0.67	0.62	40.7
9	R2	46	3	48	6.5	0.135	10.5	LOS A	0.8	6.2	0.62	0.67	0.62	42.6
Approach		94	5	99	5.3	0.135	8.9	LOS A	0.8	6.2	0.62	0.67	0.62	42.4
West: Copeland Street														
10	L2	111	5	117	4.5	0.424	4.3	LOS A	3.4	25.1	0.26	0.48	0.26	44.5
11	T1	258	21	272	8.1	0.424	4.3	LOS A	3.4	25.1	0.26	0.48	0.26	46.1
12	R2	104	2	109	1.9	0.424	7.3	LOS A	3.4	25.1	0.26	0.48	0.26	43.7
Approach		473	28	498	5.9	0.424	4.9	LOS A	3.4	25.1	0.26	0.48	0.26	45.3
All Vehicles		1177	60	1239	5.1	0.654	6.4	LOS A	6.6	47.7	0.52	0.59	0.53	44.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Development Conditions Copeland Street and Phillip Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Phillip Street														
1	L2	60	2	63	3.3	0.136	8.3	LOS A	0.7	4.8	0.64	0.75	0.64	40.3
2	T1	14	0	15	0.0	0.136	7.9	LOS A	0.7	4.8	0.64	0.75	0.64	41.1
3	R2	7	0	7	0.0	0.136	11.0	LOS A	0.7	4.8	0.64	0.75	0.64	42.5
Approach		81	2	85	2.5	0.136	8.4	LOS A	0.7	4.8	0.64	0.75	0.64	40.6
East: Copeland Street														
4	L2	31	0	33	0.0	0.511	4.3	LOS A	4.8	34.1	0.32	0.43	0.32	44.4
5	T1	558	7	587	1.3	0.511	4.2	LOS A	4.8	34.1	0.32	0.43	0.32	46.3
6	R2	2	0	2	0.0	0.511	7.3	LOS A	4.8	34.1	0.32	0.43	0.32	46.0
Approach		591	7	622	1.2	0.511	4.2	LOS A	4.8	34.1	0.32	0.43	0.32	46.2
North: Phillip Street														
7	L2	9	0	9	0.0	0.059	7.9	LOS A	0.4	2.9	0.64	0.67	0.64	42.5
8	T1	7	2	7	28.6	0.059	9.0	LOS A	0.4	2.9	0.64	0.67	0.64	39.4
9	R2	20	4	21	20.0	0.059	11.7	LOS A	0.4	2.9	0.64	0.67	0.64	41.5
Approach		36	6	38	16.7	0.059	10.2	LOS A	0.4	2.9	0.64	0.67	0.64	41.5
West: Copeland Street														
10	L2	28	2	29	7.1	0.395	4.0	LOS A	3.3	23.6	0.18	0.42	0.18	45.1
11	T1	441	12	464	2.7	0.395	3.9	LOS A	3.3	23.6	0.18	0.42	0.18	46.7
12	R2	15	2	16	13.3	0.395	7.2	LOS A	3.3	23.6	0.18	0.42	0.18	43.3
Approach		484	16	509	3.3	0.395	4.0	LOS A	3.3	23.6	0.18	0.42	0.18	46.6
All Vehicles		1192	31	1255	2.6	0.511	4.6	LOS A	4.8	34.1	0.29	0.45	0.29	45.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Future Conditions Copeland Street and Phillip Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Phillip Street														
1	L2	32	4	34	12.5	0.125	9.9	LOS A	0.7	5.5	0.77	0.84	0.77	38.7
2	T1	11	2	12	18.2	0.125	10.0	LOS A	0.7	5.5	0.77	0.84	0.77	39.2
3	R2	7	2	7	28.6	0.125	13.7	LOS A	0.7	5.5	0.77	0.84	0.77	40.7
Approach		50	8	53	16.0	0.125	10.5	LOS A	0.7	5.5	0.77	0.84	0.77	39.1
East: Copeland Street														
4	L2	46	3	48	6.5	0.820	12.8	LOS A	14.6	105.2	0.97	0.90	1.21	39.1
5	T1	615	19	647	3.1	0.820	12.5	LOS A	14.6	105.2	0.97	0.90	1.21	41.8
6	R2	28	0	29	0.0	0.820	15.5	LOS B	14.6	105.2	0.97	0.90	1.21	41.4
Approach		689	22	725	3.2	0.820	12.7	LOS A	14.6	105.2	0.97	0.90	1.21	41.6
North: Phillip Street														
7	L2	28	0	29	0.0	0.175	8.1	LOS A	1.1	8.3	0.68	0.72	0.68	42.7
8	T1	30	2	32	6.7	0.175	8.3	LOS A	1.1	8.3	0.68	0.72	0.68	40.0
9	R2	56	3	59	5.4	0.175	11.3	LOS A	1.1	8.3	0.68	0.72	0.68	42.1
Approach		114	5	120	4.4	0.175	9.7	LOS A	1.1	8.3	0.68	0.72	0.68	41.8
West: Copeland Street														
10	L2	135	5	142	3.7	0.508	4.4	LOS A	4.8	35.3	0.32	0.48	0.32	44.4
11	T1	309	25	325	8.1	0.508	4.5	LOS A	4.8	35.3	0.32	0.48	0.32	45.9
12	R2	118	2	124	1.7	0.508	7.5	LOS A	4.8	35.3	0.32	0.48	0.32	43.5
Approach		562	32	592	5.7	0.508	5.1	LOS A	4.8	35.3	0.32	0.48	0.32	45.2
All Vehicles		1415	67	1489	4.7	0.820	9.3	LOS A	14.6	105.2	0.68	0.71	0.80	42.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Future Conditions Copeland Street and Phillip Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Phillip Street														
1	L2	69	2	73	2.9	0.182	9.7	LOS A	1.0	6.9	0.72	0.82	0.72	39.2
2	T1	17	0	18	0.0	0.182	9.3	LOS A	1.0	6.9	0.72	0.82	0.72	39.9
3	R2	8	0	8	0.0	0.182	12.4	LOS A	1.0	6.9	0.72	0.82	0.72	41.5
Approach		94	2	99	2.1	0.182	9.8	LOS A	1.0	6.9	0.72	0.82	0.72	39.5
East: Copeland Street														
4	L2	38	0	40	0.0	0.616	4.5	LOS A	7.0	49.2	0.40	0.44	0.40	44.1
5	T1	670	2	705	0.3	0.616	4.4	LOS A	7.0	49.2	0.40	0.44	0.40	46.0
6	R2	8	0	8	0.0	0.616	7.4	LOS A	7.0	49.2	0.40	0.44	0.40	45.7
Approach		716	2	754	0.3	0.616	4.4	LOS A	7.0	49.2	0.40	0.44	0.40	45.9
North: Phillip Street														
7	L2	10	0	11	0.0	0.073	9.1	LOS A	0.5	3.6	0.71	0.71	0.71	41.7
8	T1	7	2	7	28.6	0.073	10.4	LOS A	0.5	3.6	0.71	0.71	0.71	38.3
9	R2	23	4	24	17.4	0.073	13.0	LOS A	0.5	3.6	0.71	0.71	0.71	40.7
Approach		40	6	42	15.0	0.073	11.6	LOS A	0.5	3.6	0.71	0.71	0.71	40.7
West: Copeland Street														
10	L2	34	2	36	5.9	0.493	4.2	LOS A	4.7	33.8	0.25	0.42	0.25	44.9
11	T1	537	14	565	2.6	0.493	4.1	LOS A	4.7	33.8	0.25	0.42	0.25	46.5
12	R2	17	2	18	11.8	0.493	7.3	LOS A	4.7	33.8	0.25	0.42	0.25	43.2
Approach		588	18	619	3.1	0.493	4.2	LOS A	4.7	33.8	0.25	0.42	0.25	46.3
All Vehicles		1438	28	1514	1.9	0.616	4.9	LOS A	7.0	49.2	0.37	0.46	0.37	45.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

INTERSECTION SUMMARY

Site: 101 [Existing Conditions Copeland Street and Richmond Road AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Intersection Performance - Hourly Values				
Performance Measure	**Vehicles**		**Persons**	
Travel Speed (Average)	45.9	km/h	45.9	km/h
Travel Distance (Total)	1318.7	veh-km/h	1582.5	pers-km/h
Travel Time (Total)	28.8	veh-h/h	34.5	pers-h/h
Desired Speed (Program)	50.0	km/h		
Speed Efficiency	0.92			
Travel Time Index	9.08			
Congestion Coefficient	1.09			
Demand Flows (Total)	1285	veh/h	1542	pers/h
Percent Heavy Vehicles (Demand)	3.5	%		
Degree of Saturation	0.538			
Practical Spare Capacity	57.9	%		
Effective Intersection Capacity	2388	veh/h		
Control Delay (Total)	2.42	veh-h/h	2.91	pers-h/h
Control Delay (Average)	6.8	sec	6.8	sec
Control Delay (Worst Lane)	9.8	sec		
Control Delay (Worst Movement)	12.5	sec	12.5	sec
Geometric Delay (Average)	4.3	sec		
Stop-Line Delay (Average)	2.5	sec		
Idling Time (Average)	0.4	sec		
Intersection Level of Service (LOS)	LOS A			
95% Back of Queue - Vehicles (Worst Lane)	3.6	veh		
95% Back of Queue - Distance (Worst Lane)	26.1	m		
Ave. Queue Storage Ratio (Worst Lane)	0.02			
Total Effective Stops	858	veh/h	1029	pers/h
Effective Stop Rate	0.67		0.67	
Proportion Queued	0.58		0.58	
Performance Index	55.2		55.2	
Cost (Total)	1211.71	$/h	1211.71	$/h
Fuel Consumption (Total)	115.2	L/h		
Carbon Dioxide (Total)	273.4	kg/h		
Hydrocarbons (Total)	0.020	kg/h		
Carbon Monoxide (Total)	0.222	kg/h		
NOx (Total)	0.416	kg/h		

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 2.1 %
Number of Iterations: 6 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 2.5% 1.3% 0.7%

Intersection Performance - Annual Values				
Performance Measure	**Vehicles**		**Persons**	
Demand Flows (Total)	616,926	veh/y	740,312	pers/y
Delay	1,163	veh-h/y	1,395	pers-h/y
Effective Stops	411,717	veh/y	494,061	pers/y
Travel Distance	632,999	veh-km/y	759,599	pers-km/y
Travel Time	13,805	veh-h/y	16,566	pers-h/y
Cost	581,620	$/y	581,620	$/y
Fuel Consumption	55,294	L/y		
Carbon Dioxide	131,230	kg/y		
Hydrocarbons	10	kg/y		
Carbon Monoxide	107	kg/y		

NOx	200 kg/y

INTERSECTION SUMMARY

Site: 101 [Existing Conditions Copeland Street and Richmond Road PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Intersection Performance - Hourly Values				
Performance Measure	**Vehicles**		**Persons**	
Travel Speed (Average)	45.9	km/h	45.9	km/h
Travel Distance (Total)	1486.5	veh-km/h	1783.8	pers-km/h
Travel Time (Total)	32.4	veh-h/h	38.9	pers-h/h
Desired Speed (Program)	50.0	km/h		
Speed Efficiency	0.92			
Travel Time Index	9.09			
Congestion Coefficient	1.09			
Demand Flows (Total)	1449	veh/h	1739	pers/h
Percent Heavy Vehicles (Demand)	2.8	%		
Degree of Saturation	0.588			
Practical Spare Capacity	44.5	%		
Effective Intersection Capacity	2465	veh/h		
Control Delay (Total)	2.62	veh-h/h	3.15	pers-h/h
Control Delay (Average)	6.5	sec	6.5	sec
Control Delay (Worst Lane)	9.7	sec		
Control Delay (Worst Movement)	12.6	sec	12.6	sec
Geometric Delay (Average)	4.1	sec		
Stop-Line Delay (Average)	2.5	sec		
Idling Time (Average)	0.4	sec		
Intersection Level of Service (LOS)	LOS A			
95% Back of Queue - Vehicles (Worst Lane)	4.3	veh		
95% Back of Queue - Distance (Worst Lane)	30.4	m		
Ave. Queue Storage Ratio (Worst Lane)	0.02			
Total Effective Stops	946	veh/h	1135	pers/h
Effective Stop Rate	0.65		0.65	
Proportion Queued	0.61		0.61	
Performance Index	63.5		63.5	
Cost (Total)	1355.39	$/h	1355.39	$/h
Fuel Consumption (Total)	125.7	L/h		
Carbon Dioxide (Total)	297.8	kg/h		
Hydrocarbons (Total)	0.022	kg/h		
Carbon Monoxide (Total)	0.242	kg/h		
NOx (Total)	0.384	kg/h		

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 2.4 %
Number of Iterations: 6 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 2.9% 1.6% 0.8%

Intersection Performance - Annual Values				
Performance Measure	**Vehicles**		**Persons**	
Demand Flows (Total)	695,747	veh/y	834,897	pers/y
Delay	1,258	veh-h/y	1,510	pers-h/y
Effective Stops	453,864	veh/y	544,636	pers/y
Travel Distance	713,527	veh-km/y	856,233	pers-km/y
Travel Time	15,544	veh-h/y	18,653	pers-h/y
Cost	650,587	$/y	650,587	$/y
Fuel Consumption	60,344	L/y		
Carbon Dioxide	142,942	kg/y		
Hydrocarbons	10	kg/y		
Carbon Monoxide	116	kg/y		

NOx	184 kg/y

INTERSECTION SUMMARY

Site: 101 [Development Conditions Copeland Street and Richmond Road AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Intersection Performance - Hourly Values

Performance Measure	Vehicles		Persons	
Travel Speed (Average)	45.6	km/h	45.6	km/h
Travel Distance (Total)	1441.7	veh-km/h	1730.0	pers-km/h
Travel Time (Total)	31.6	veh-h/h	38.0	pers-h/h
Desired Speed (Program)	50.0	km/h		
Speed Efficiency	0.91			
Travel Time Index	9.01			
Congestion Coefficient	1.10			
Demand Flows (Total)	1405	veh/h	1686	pers/h
Percent Heavy Vehicles (Demand)	4.0	%		
Degree of Saturation	0.618			
Practical Spare Capacity	37.6	%		
Effective Intersection Capacity	2276	veh/h		
Control Delay (Total)	2.95	veh-h/h	3.54	pers-h/h
Control Delay (Average)	7.6	sec	7.6	sec
Control Delay (Worst Lane)	10.1	sec		
Control Delay (Worst Movement)	12.9	sec	12.9	sec
Geometric Delay (Average)	4.2	sec		
Stop-Line Delay (Average)	3.3	sec		
Idling Time (Average)	0.5	sec		
Intersection Level of Service (LOS)	LOS A			
95% Back of Queue - Vehicles (Worst Lane)	5.1	veh		
95% Back of Queue - Distance (Worst Lane)	36.6	m		
Ave. Queue Storage Ratio (Worst Lane)	0.03			
Total Effective Stops	1026	veh/h	1232	pers/h
Effective Stop Rate	0.73		0.73	
Proportion Queued	0.65		0.65	
Performance Index	64.9		64.9	
Cost (Total)	1339.40	$/h	1339.40	$/h
Fuel Consumption (Total)	129.5	L/h		
Carbon Dioxide (Total)	307.7	kg/h		
Hydrocarbons (Total)	0.023	kg/h		
Carbon Monoxide (Total)	0.251	kg/h		
NOx (Total)	0.518	kg/h		

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 2.6 %
Number of Iterations: 6 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 3.1% 1.6% 0.8%

Intersection Performance - Annual Values

Performance Measure	Vehicles		Persons	
Demand Flows (Total)	674,526	veh/y	809,432	pers/y
Delay	1,416	veh-h/y	1,699	pers-h/y
Effective Stops	492,684	veh/y	591,221	pers/y
Travel Distance	692,007	veh-km/y	830,408	pers-km/y
Travel Time	15,190	veh-h/y	18,228	pers-h/y
Cost	642,913	$/y	642,913	$/y
Fuel Consumption	62,147	L/y		
Carbon Dioxide	147,675	kg/y		
Hydrocarbons	11	kg/y		
Carbon Monoxide	121	kg/y		

NOx	249 kg/y

INTERSECTION SUMMARY

Site: 101 [Development Conditions Copeland Street and Richmond Road PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Intersection Performance - Hourly Values				
Performance Measure	**Vehicles**		**Persons**	
Travel Speed (Average)	45.5	km/h	45.5	km/h
Travel Distance (Total)	1608.6	veh-km/h	1930.3	pers-km/h
Travel Time (Total)	35.4	veh-h/h	42.4	pers-h/h
Desired Speed (Program)	50.0	km/h		
Speed Efficiency	0.91			
Travel Time Index	9.00			
Congestion Coefficient	1.10			
Demand Flows (Total)	1568	veh/h	1882	pers/h
Percent Heavy Vehicles (Demand)	3.3	%		
Degree of Saturation	0.613			
Practical Spare Capacity	38.7	%		
Effective Intersection Capacity	2559	veh/h		
Control Delay (Total)	3.25	veh-h/h	3.90	pers-h/h
Control Delay (Average)	7.5	sec	7.5	sec
Control Delay (Worst Lane)	11.4	sec		
Control Delay (Worst Movement)	14.1	sec	14.1	sec
Geometric Delay (Average)	4.1	sec		
Stop-Line Delay (Average)	3.4	sec		
Idling Time (Average)	0.7	sec		
Intersection Level of Service (LOS)	LOS A			
95% Back of Queue - Vehicles (Worst Lane)	4.8	veh		
95% Back of Queue - Distance (Worst Lane)	34.4	m		
Ave. Queue Storage Ratio (Worst Lane)	0.03			
Total Effective Stops	1138	veh/h	1366	pers/h
Effective Stop Rate	0.73		0.73	
Proportion Queued	0.68		0.68	
Performance Index	73.9		73.9	
Cost (Total)	1486.55	$/h	1486.55	$/h
Fuel Consumption (Total)	140.2	L/h		
Carbon Dioxide (Total)	332.4	kg/h		
Hydrocarbons (Total)	0.024	kg/h		
Carbon Monoxide (Total)	0.271	kg/h		
NOx (Total)	0.486	kg/h		

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 2.7 %
Number of Iterations: 6 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 3.2% 1.7% 0.9%

Intersection Performance - Annual Values				
Performance Measure	**Vehicles**		**Persons**	
Demand Flows (Total)	752,842	veh/y	903,411	pers/y
Delay	1,558	veh-h/y	1,870	pers-h/y
Effective Stops	546,466	veh/y	655,759	pers/y
Travel Distance	772,121	veh-km/y	926,546	pers-km/y
Travel Time	16,974	veh-h/y	20,369	pers-h/y
Cost	713,544	$/y	713,544	$/y
Fuel Consumption	67,274	L/y		
Carbon Dioxide	159,567	kg/y		
Hydrocarbons	12	kg/y		
Carbon Monoxide	130	kg/y		

NOx	233 kg/y

INTERSECTION SUMMARY

Site: 101 [Future Conditions Copeland Street and Richmond Road AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	44.1 km/h	44.1 km/h
Travel Distance (Total)	1732.3 veh-km/h	2078.7 pers-km/h
Travel Time (Total)	39.3 veh-h/h	47.1 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.88	
Travel Time Index	8.69	
Congestion Coefficient	1.13	
Demand Flows (Total)	1688 veh/h	2026 pers/h
Percent Heavy Vehicles (Demand)	3.7 %	
Degree of Saturation	0.792	
Practical Spare Capacity	7.3 %	
Effective Intersection Capacity	2132 veh/h	
Control Delay (Total)	4.83 veh-h/h	5.79 pers-h/h
Control Delay (Average)	10.3 sec	10.3 sec
Control Delay (Worst Lane)	14.7 sec	
Control Delay (Worst Movement)	17.5 sec	17.5 sec
Geometric Delay (Average)	4.2 sec	
Stop-Line Delay (Average)	6.0 sec	
Idling Time (Average)	1.7 sec	
Intersection Level of Service (LOS)	LOS A	
95% Back of Queue - Vehicles (Worst Lane)	10.0 veh	
95% Back of Queue - Distance (Worst Lane)	71.5 m	
Ave. Queue Storage Ratio (Worst Lane)	0.06	
Total Effective Stops	1507 veh/h	1808 pers/h
Effective Stop Rate	0.89	0.89
Proportion Queued	0.79	0.79
Performance Index	95.4	95.4
Cost (Total)	1654.20 $/h	1654.20 $/h
Fuel Consumption (Total)	157.2 L/h	
Carbon Dioxide (Total)	373.1 kg/h	
Hydrocarbons (Total)	0.028 kg/h	
Carbon Monoxide (Total)	0.305 kg/h	
NOx (Total)	0.587 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 3.8 %
Number of Iterations: 7 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 3.1% 1.6% 0.8%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	810,442 veh/y	972,531 pers/y
Delay	2,317 veh-h/y	2,781 pers-h/y
Effective Stops	723,357 veh/y	868,028 pers/y
Travel Distance	831,482 veh-km/y	997,778 pers-km/y
Travel Time	18,849 veh-h/y	22,619 pers-h/y
Cost	794,018 $/y	794,018 $/y
Fuel Consumption	75,437 L/y	
Carbon Dioxide	179,065 kg/y	
Hydrocarbons	13 kg/y	
Carbon Monoxide	146 kg/y	

NOx	282 kg/y

INTERSECTION SUMMARY

Site: 101 [Future Conditions Copeland Street and Richmond Road PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	44.0 km/h	44.0 km/h
Travel Distance (Total)	1933.5 veh-km/h	2320.2 pers-km/h
Travel Time (Total)	44.0 veh-h/h	52.8 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.88	
Travel Time Index	8.66	
Congestion Coefficient	1.14	
Demand Flows (Total)	1885 veh/h	2262 pers/h
Percent Heavy Vehicles (Demand)	3.0 %	
Degree of Saturation	0.778	
Practical Spare Capacity	9.3 %	
Effective Intersection Capacity	2424 veh/h	
Control Delay (Total)	5.62 veh-h/h	6.75 pers-h/h
Control Delay (Average)	10.7 sec	10.7 sec
Control Delay (Worst Lane)	18.6 sec	
Control Delay (Worst Movement)	21.4 sec	21.4 sec
Geometric Delay (Average)	4.1 sec	
Stop-Line Delay (Average)	6.7 sec	
Idling Time (Average)	1.8 sec	
Intersection Level of Service (LOS)	LOS A	
95% Back of Queue - Vehicles (Worst Lane)	9.8 veh	
95% Back of Queue - Distance (Worst Lane)	69.1 m	
Ave. Queue Storage Ratio (Worst Lane)	0.06	
Total Effective Stops	1702 veh/h	2043 pers/h
Effective Stop Rate	0.90	0.90
Proportion Queued	0.85	0.85
Performance Index	113.0	113.0
Cost (Total)	1840.80 $/h	1840.80 $/h
Fuel Consumption (Total)	170.9 L/h	
Carbon Dioxide (Total)	404.8 kg/h	
Hydrocarbons (Total)	0.030 kg/h	
Carbon Monoxide (Total)	0.331 kg/h	
NOx (Total)	0.549 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 4.3 %
Number of Iterations: 7 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 3.5% 1.9% 0.9%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	904,926 veh/y	1,085,912 pers/y
Delay	2,699 veh-h/y	3,238 pers-h/y
Effective Stops	817,178 veh/y	980,614 pers/y
Travel Distance	928,094 veh-km/y	1,113,713 pers-km/y
Travel Time	21,107 veh-h/y	25,328 pers-h/y
Cost	883,583 $/y	883,583 $/y
Fuel Consumption	82,008 L/y	
Carbon Dioxide	194,328 kg/y	
Hydrocarbons	14 kg/y	
Carbon Monoxide	159 kg/y	

NOx	264 kg/y

MOVEMENT SUMMARY

Site: 101 [Existing Conditions Copeland Street and Richmond Road AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Richmond Road														
1	L2	58	2	61	3.4	0.295	8.8	LOS A	1.7	12.5	0.75	0.83	0.75	43.8
2	T1	64	1	67	1.6	0.295	8.8	LOS A	1.7	12.5	0.75	0.83	0.75	44.6
3	R2	44	1	46	2.3	0.295	12.5	LOS A	1.7	12.5	0.75	0.83	0.75	44.6
Approach		166	4	175	2.4	0.295	9.8	LOS A	1.7	12.5	0.75	0.83	0.75	44.3
East: Victoria Street														
4	L2	28	1	29	3.6	0.538	5.6	LOS A	3.6	26.1	0.60	0.67	0.61	45.4
5	T1	361	11	380	3.0	0.538	5.5	LOS A	3.6	26.1	0.60	0.67	0.61	46.2
6	R2	86	1	91	1.2	0.538	9.3	LOS A	3.6	26.1	0.60	0.67	0.61	46.2
Approach		475	13	500	2.7	0.538	6.2	LOS A	3.6	26.1	0.60	0.67	0.61	46.2
North: Richmond Road														
7	L2	104	2	109	1.9	0.355	5.3	LOS A	2.3	16.2	0.57	0.66	0.57	45.2
8	T1	80	0	84	0.0	0.355	5.3	LOS A	2.3	16.2	0.57	0.66	0.57	46.1
9	R2	143	3	151	2.1	0.355	9.2	LOS A	2.3	16.2	0.57	0.66	0.57	46.0
Approach		327	5	344	1.5	0.355	7.0	LOS A	2.3	16.2	0.57	0.66	0.57	45.8
West: Copeland Street														
10	L2	31	5	33	16.1	0.281	5.1	LOS A	1.7	12.6	0.48	0.56	0.48	45.6
11	T1	179	12	188	6.7	0.281	4.9	LOS A	1.7	12.6	0.48	0.56	0.48	46.6
12	R2	43	4	45	9.3	0.281	8.7	LOS A	1.7	12.6	0.48	0.56	0.48	46.5
Approach		253	21	266	8.3	0.281	5.6	LOS A	1.7	12.6	0.48	0.56	0.48	46.4
All Vehicles		1221	43	1285	3.5	0.538	6.8	LOS A	3.6	26.1	0.58	0.67	0.59	45.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Existing Conditions Copeland Street and Richmond Road PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Richmond Road														
1	L2	49	2	52	4.1	0.265	9.0	LOS A	1.6	11.2	0.76	0.83	0.76	43.8
2	T1	67	2	71	3.0	0.265	9.0	LOS A	1.6	11.2	0.76	0.83	0.76	44.6
3	R2	27	0	28	0.0	0.265	12.6	LOS A	1.6	11.2	0.76	0.83	0.76	44.6
Approach		143	4	151	2.8	0.265	9.7	LOS A	1.6	11.2	0.76	0.83	0.76	44.4
East: Victoria Street														
4	L2	34	1	36	2.9	0.588	5.1	LOS A	4.3	30.4	0.58	0.62	0.58	45.4
5	T1	413	2	435	0.5	0.588	5.0	LOS A	4.3	30.4	0.58	0.62	0.58	46.3
6	R2	121	4	127	3.3	0.588	8.9	LOS A	4.3	30.4	0.58	0.62	0.58	46.2
Approach		568	7	598	1.2	0.588	5.8	LOS A	4.3	30.4	0.58	0.62	0.58	46.2
North: Richmond Road														
7	L2	61	1	64	1.6	0.273	6.0	LOS A	1.7	12.3	0.63	0.71	0.63	44.8
8	T1	65	13	68	20.0	0.273	6.6	LOS A	1.7	12.3	0.63	0.71	0.63	45.5
9	R2	87	2	92	2.3	0.273	9.9	LOS A	1.7	12.3	0.63	0.71	0.63	45.6
Approach		213	16	224	7.5	0.273	7.7	LOS A	1.7	12.3	0.63	0.71	0.63	45.4
West: Copeland Street														
10	L2	90	5	95	5.6	0.477	5.4	LOS A	3.4	24.7	0.58	0.61	0.58	45.5
11	T1	312	4	328	1.3	0.477	5.3	LOS A	3.4	24.7	0.58	0.61	0.58	46.4
12	R2	51	2	54	3.9	0.477	9.1	LOS A	3.4	24.7	0.58	0.61	0.58	46.4
Approach		453	11	477	2.4	0.477	5.8	LOS A	3.4	24.7	0.58	0.61	0.58	46.2
All Vehicles		1377	38	1449	2.8	0.588	6.5	LOS A	4.3	30.4	0.61	0.65	0.61	45.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Development Conditions Copeland Street and Richmond Road AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	INPUT VOLUMES HV] veh/h	DEMAND FLOWS [Total veh/h	DEMAND FLOWS HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	95% BACK OF QUEUE Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Richmond Road														
1	L2	61	3	64	4.9	0.324	9.2	LOS A	2.0	14.3	0.78	0.86	0.78	43.6
2	T1	67	2	71	3.0	0.324	9.1	LOS A	2.0	14.3	0.78	0.86	0.78	44.4
3	R2	46	2	48	4.3	0.324	12.9	LOS A	2.0	14.3	0.78	0.86	0.78	44.4
Approach		174	7	183	4.0	0.324	10.1	LOS A	2.0	14.3	0.78	0.86	0.78	44.1
East: Victoria Street														
4	L2	51	2	54	3.9	0.618	7.3	LOS A	5.1	36.6	0.70	0.80	0.80	44.8
5	T1	369	12	388	3.3	0.618	7.2	LOS A	5.1	36.6	0.70	0.80	0.80	45.7
6	R2	89	2	94	2.2	0.618	11.0	LOS A	5.1	36.6	0.70	0.80	0.80	45.7
Approach		509	16	536	3.1	0.618	7.9	LOS A	5.1	36.6	0.70	0.80	0.80	45.6
North: Richmond Road														
7	L2	108	3	114	2.8	0.417	5.7	LOS A	2.8	20.1	0.62	0.69	0.62	45.1
8	T1	119	0	125	0.0	0.417	5.6	LOS A	2.8	20.1	0.62	0.69	0.62	45.9
9	R2	147	4	155	2.7	0.417	9.5	LOS A	2.8	20.1	0.62	0.69	0.62	45.9
Approach		374	7	394	1.9	0.417	7.2	LOS A	2.8	20.1	0.62	0.69	0.62	45.7
West: Copeland Street														
10	L2	33	6	35	18.2	0.311	5.3	LOS A	1.9	14.5	0.50	0.58	0.50	45.4
11	T1	184	13	194	7.1	0.311	5.0	LOS A	1.9	14.5	0.50	0.58	0.50	46.4
12	R2	61	5	64	8.2	0.311	8.8	LOS A	1.9	14.5	0.50	0.58	0.50	46.3
Approach		278	24	293	8.6	0.311	5.9	LOS A	1.9	14.5	0.50	0.58	0.50	46.3
All Vehicles		1335	54	1405	4.0	0.618	7.6	LOS A	5.1	36.6	0.65	0.73	0.69	45.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Development Conditions Copeland Street and Richmond Road PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Richmond Road														
1	L2	62	3	65	4.8	0.415	10.6	LOS A	2.8	20.1	0.83	0.94	0.90	43.0
2	T1	107	3	113	2.8	0.415	10.5	LOS A	2.8	20.1	0.83	0.94	0.90	43.8
3	R2	49	0	52	0.0	0.415	14.1	LOS A	2.8	20.1	0.83	0.94	0.90	43.7
Approach		218	6	229	2.8	0.415	11.4	LOS A	2.8	20.1	0.83	0.94	0.90	43.5
East: Victoria Street														
4	L2	36	2	38	5.6	0.613	5.5	LOS A	4.8	34.4	0.61	0.65	0.63	45.3
5	T1	423	3	445	0.7	0.613	5.4	LOS A	4.8	34.4	0.61	0.65	0.63	46.2
6	R2	125	5	132	4.0	0.613	9.3	LOS A	4.8	34.4	0.61	0.65	0.63	46.1
Approach		584	10	615	1.7	0.613	6.2	LOS A	4.8	34.4	0.61	0.65	0.63	46.1
North: Richmond Road														
7	L2	64	2	67	3.1	0.298	6.4	LOS A	1.9	14.0	0.67	0.74	0.67	44.6
8	T1	68	14	72	20.6	0.298	6.9	LOS A	1.9	14.0	0.67	0.74	0.67	45.4
9	R2	90	3	95	3.3	0.298	10.2	LOS A	1.9	14.0	0.67	0.74	0.67	45.4
Approach		222	19	234	8.6	0.298	8.1	LOS A	1.9	14.0	0.67	0.74	0.67	45.2
West: Copeland Street														
10	L2	93	6	98	6.5	0.540	6.6	LOS A	4.3	30.8	0.69	0.71	0.72	45.1
11	T1	320	5	337	1.6	0.540	6.4	LOS A	4.3	30.8	0.69	0.71	0.72	46.0
12	R2	53	3	56	5.7	0.540	10.3	LOS A	4.3	30.8	0.69	0.71	0.72	45.9
Approach		466	14	491	3.0	0.540	6.9	LOS A	4.3	30.8	0.69	0.71	0.72	45.8
All Vehicles		1490	49	1568	3.3	0.613	7.5	LOS A	4.8	34.4	0.68	0.73	0.70	45.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Future Conditions Copeland Street and Richmond Road AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Richmond Road														
1	L2	73	3	77	4.1	0.483	13.7	LOS A	3.6	26.2	0.91	1.03	1.08	41.4
2	T1	81	2	85	2.5	0.483	13.7	LOS A	3.6	26.2	0.91	1.03	1.08	42.1
3	R2	56	2	59	3.6	0.483	17.5	LOS B	3.6	26.2	0.91	1.03	1.08	42.0
Approach		210	7	221	3.3	0.483	14.7	LOS B	3.6	26.2	0.91	1.03	1.08	41.8
East: Victoria Street														
4	L2	57	2	60	3.5	0.792	11.6	LOS A	10.0	71.5	0.91	1.06	1.25	42.6
5	T1	450	14	474	3.1	0.792	11.5	LOS A	10.0	71.5	0.91	1.06	1.25	43.4
6	R2	108	2	114	1.9	0.792	15.3	LOS B	10.0	71.5	0.91	1.06	1.25	43.3
Approach		615	18	647	2.9	0.792	12.2	LOS A	10.0	71.5	0.91	1.06	1.25	43.3
North: Richmond Road														
7	L2	130	3	137	2.3	0.528	7.0	LOS A	4.2	30.0	0.73	0.79	0.78	44.5
8	T1	137	0	144	0.0	0.528	6.9	LOS A	4.2	30.0	0.73	0.79	0.78	45.3
9	R2	179	4	188	2.2	0.528	10.8	LOS A	4.2	30.0	0.73	0.79	0.78	45.3
Approach		446	7	469	1.6	0.528	8.5	LOS A	4.2	30.0	0.73	0.79	0.78	45.1
West: Copeland Street														
10	L2	40	7	42	17.5	0.391	5.9	LOS A	2.6	19.4	0.58	0.64	0.58	45.2
11	T1	223	15	235	6.7	0.391	5.5	LOS A	2.6	19.4	0.58	0.64	0.58	46.2
12	R2	70	5	74	7.1	0.391	9.3	LOS A	2.6	19.4	0.58	0.64	0.58	46.1
Approach		333	27	351	8.1	0.391	6.4	LOS A	2.6	19.4	0.58	0.64	0.58	46.0
All Vehicles		1604	59	1688	3.7	0.792	10.3	LOS A	10.0	71.5	0.79	0.89	0.96	44.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Future Conditions Copeland Street and Richmond Road PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Richmond Road														
1	L2	73	3	77	4.1	0.601	17.9	LOS B	5.3	37.8	0.96	1.12	1.31	39.6
2	T1	121	3	127	2.5	0.601	17.8	LOS B	5.3	37.8	0.96	1.12	1.31	40.3
3	R2	55	0	58	0.0	0.601	21.4	LOS B	5.3	37.8	0.96	1.12	1.31	40.3
Approach		249	6	262	2.4	0.601	18.6	LOS B	5.3	37.8	0.96	1.12	1.31	40.1
East: Victoria Street														
4	L2	44	2	46	4.5	0.778	8.6	LOS A	9.8	69.1	0.83	0.86	1.00	44.1
5	T1	515	3	542	0.6	0.778	8.5	LOS A	9.8	69.1	0.83	0.86	1.00	44.9
6	R2	151	5	159	3.3	0.778	12.4	LOS A	9.8	69.1	0.83	0.86	1.00	44.8
Approach		710	10	747	1.4	0.778	9.3	LOS A	9.8	69.1	0.83	0.86	1.00	44.9
North: Richmond Road														
7	L2	77	2	81	2.6	0.403	7.3	LOS A	2.7	20.6	0.78	0.83	0.78	44.2
8	T1	82	17	86	20.7	0.403	8.0	LOS A	2.7	20.6	0.78	0.83	0.78	44.9
9	R2	109	3	115	2.8	0.403	11.1	LOS A	2.7	20.6	0.78	0.83	0.78	44.9
Approach		268	22	282	8.2	0.403	9.1	LOS A	2.7	20.6	0.78	0.83	0.78	44.7
West: Copeland Street														
10	L2	112	7	118	6.3	0.685	9.6	LOS A	7.7	54.8	0.84	0.89	1.02	43.8
11	T1	388	5	408	1.3	0.685	9.4	LOS A	7.7	54.8	0.84	0.89	1.02	44.6
12	R2	64	3	67	4.7	0.685	13.3	LOS A	7.7	54.8	0.84	0.89	1.02	44.5
Approach		564	15	594	2.7	0.685	9.8	LOS A	7.7	54.8	0.84	0.89	1.02	44.4
All Vehicles		1791	53	1885	3.0	0.778	10.7	LOS A	9.8	69.1	0.85	0.90	1.02	44.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

INTERSECTION SUMMARY

Site: 101 [Existing Conditions Heath Street and Victoria Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	49.4 km/h	49.4 km/h
Travel Distance (Total)	665.7 veh-km/h	798.8 pers-km/h
Travel Time (Total)	13.5 veh-h/h	16.2 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.99	
Travel Time Index	9.87	
Congestion Coefficient	1.01	
Demand Flows (Total)	657 veh/h	788 pers/h
Percent Heavy Vehicles (Demand)	3.5 %	
Degree of Saturation	0.180	
Practical Spare Capacity	445.6 %	
Effective Intersection Capacity	3657 veh/h	
Control Delay (Total)	0.14 veh-h/h	0.17 pers-h/h
Control Delay (Average)	0.8 sec	0.8 sec
Control Delay (Worst Lane)	8.8 sec	
Control Delay (Worst Movement)	9.6 sec	9.6 sec
Geometric Delay (Average)	0.5 sec	
Stop-Line Delay (Average)	0.3 sec	
Idling Time (Average)	0.1 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	0.1 veh	
95% Back of Queue - Distance (Worst Lane)	1.1 m	
Ave. Queue Storage Ratio (Worst Lane)	0.00	
Total Effective Stops	40 veh/h	48 pers/h
Effective Stop Rate	0.06	0.06
Proportion Queued	0.04	0.04
Performance Index	14.1	14.1
Cost (Total)	549.63 $/h	549.63 $/h
Fuel Consumption (Total)	46.0 L/h	
Carbon Dioxide (Total)	109.3 kg/h	
Hydrocarbons (Total)	0.007 kg/h	
Carbon Monoxide (Total)	0.086 kg/h	
NOx (Total)	0.147 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 0.0 %
Number of Iterations: 3 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 68.9% 4.5% 0.0%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	315,284 veh/y	378,341 pers/y
Delay	66 veh-h/y	80 pers-h/y
Effective Stops	19,090 veh/y	22,908 pers/y
Travel Distance	319,535 veh-km/y	383,442 pers-km/y
Travel Time	6,467 veh-h/y	7,760 pers-h/y
Cost	263,825 $/y	263,825 $/y
Fuel Consumption	22,067 L/y	
Carbon Dioxide	52,452 kg/y	
Hydrocarbons	3 kg/y	
Carbon Monoxide	41 kg/y	

NOx	71 kg/y

INTERSECTION SUMMARY

▽ Site: 101 [Existing Conditions Heath Street and Victoria Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	49.5 km/h	49.5 km/h
Travel Distance (Total)	905.7 veh-km/h	1086.9 pers-km/h
Travel Time (Total)	18.3 veh-h/h	22.0 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.99	
Travel Time Index	9.88	
Congestion Coefficient	1.01	
Demand Flows (Total)	894 veh/h	1072 pers/h
Percent Heavy Vehicles (Demand)	2.4 %	
Degree of Saturation	0.278	
Practical Spare Capacity	252.4 %	
Effective Intersection Capacity	3213 veh/h	
Control Delay (Total)	0.17 veh-h/h	0.20 pers-h/h
Control Delay (Average)	0.7 sec	0.7 sec
Control Delay (Worst Lane)	11.4 sec	
Control Delay (Worst Movement)	12.6 sec	12.6 sec
Geometric Delay (Average)	0.4 sec	
Stop-Line Delay (Average)	0.3 sec	
Idling Time (Average)	0.1 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	0.2 veh	
95% Back of Queue - Distance (Worst Lane)	1.4 m	
Ave. Queue Storage Ratio (Worst Lane)	0.00	
Total Effective Stops	47 veh/h	57 pers/h
Effective Stop Rate	0.05	0.05
Proportion Queued	0.02	0.02
Performance Index	18.8	18.8
Cost (Total)	739.08 $/h	739.08 $/h
Fuel Consumption (Total)	58.9 L/h	
Carbon Dioxide (Total)	139.5 kg/h	
Hydrocarbons (Total)	0.009 kg/h	
Carbon Monoxide (Total)	0.108 kg/h	
NOx (Total)	0.131 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 0.0 %
Number of Iterations: 3 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 78.4% 1.6% 0.0%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	428,968 veh/y	514,762 pers/y
Delay	81 veh-h/y	97 pers-h/y
Effective Stops	22,689 veh/y	27,226 pers/y
Travel Distance	434,750 veh-km/y	521,700 pers-km/y
Travel Time	8,790 veh-h/y	10,548 pers-h/y
Cost	354,758 $/y	354,758 $/y
Fuel Consumption	28,277 L/y	
Carbon Dioxide	66,977 kg/y	
Hydrocarbons	4 kg/y	
Carbon Monoxide	52 kg/y	

NOx	63 kg/y

INTERSECTION SUMMARY

▽ Site: 101 [Development Conditions Heath Street and Victoria Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	49.3 km/h	49.3 km/h
Travel Distance (Total)	699.9 veh-km/h	839.8 pers-km/h
Travel Time (Total)	14.2 veh-h/h	17.0 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.99	
Travel Time Index	9.85	
Congestion Coefficient	1.01	
Demand Flows (Total)	691 veh/h	829 pers/h
Percent Heavy Vehicles (Demand)	4.0 %	
Degree of Saturation	0.187	
Practical Spare Capacity	424.8 %	
Effective Intersection Capacity	3698 veh/h	
Control Delay (Total)	0.17 veh-h/h	0.21 pers-h/h
Control Delay (Average)	0.9 sec	0.9 sec
Control Delay (Worst Lane)	9.3 sec	
Control Delay (Worst Movement)	10.3 sec	10.3 sec
Geometric Delay (Average)	0.5 sec	
Stop-Line Delay (Average)	0.4 sec	
Idling Time (Average)	0.1 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	0.2 veh	
95% Back of Queue - Distance (Worst Lane)	1.4 m	
Ave. Queue Storage Ratio (Worst Lane)	0.00	
Total Effective Stops	48 veh/h	58 pers/h
Effective Stop Rate	0.07	0.07
Proportion Queued	0.05	0.05
Performance Index	15.0	15.0
Cost (Total)	581.81 $/h	581.81 $/h
Fuel Consumption (Total)	49.7 L/h	
Carbon Dioxide (Total)	118.2 kg/h	
Hydrocarbons (Total)	0.007 kg/h	
Carbon Monoxide (Total)	0.093 kg/h	
NOx (Total)	0.180 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 0.0 %
Number of Iterations: 3 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 69.4% 5.8% 0.0%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	331,453 veh/y	397,743 pers/y
Delay	83 veh-h/y	100 pers-h/y
Effective Stops	23,199 veh/y	27,839 pers/y
Travel Distance	335,931 veh-km/y	403,117 pers-km/y
Travel Time	6,813 veh-h/y	8,175 pers-h/y
Cost	279,267 $/y	279,267 $/y
Fuel Consumption	23,833 L/y	
Carbon Dioxide	56,732 kg/y	
Hydrocarbons	4 kg/y	
Carbon Monoxide	45 kg/y	

NOx	86 kg/y

INTERSECTION SUMMARY

Site: 101 [Development Conditions Heath Street and Victoria Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	49.4 km/h	49.4 km/h
Travel Distance (Total)	942.0 veh-km/h	1130.4 pers-km/h
Travel Time (Total)	19.1 veh-h/h	22.9 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.99	
Travel Time Index	9.86	
Congestion Coefficient	1.01	
Demand Flows (Total)	929 veh/h	1115 pers/h
Percent Heavy Vehicles (Demand)	2.6 %	
Degree of Saturation	0.284	
Practical Spare Capacity	244.5 %	
Effective Intersection Capacity	3267 veh/h	
Control Delay (Total)	0.21 veh-h/h	0.25 pers-h/h
Control Delay (Average)	0.8 sec	0.8 sec
Control Delay (Worst Lane)	12.2 sec	
Control Delay (Worst Movement)	13.3 sec	13.3 sec
Geometric Delay (Average)	0.4 sec	
Stop-Line Delay (Average)	0.4 sec	
Idling Time (Average)	0.2 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	0.3 veh	
95% Back of Queue - Distance (Worst Lane)	2.0 m	
Ave. Queue Storage Ratio (Worst Lane)	0.00	
Total Effective Stops	56 veh/h	67 pers/h
Effective Stop Rate	0.06	0.06
Proportion Queued	0.03	0.03
Performance Index	19.7	19.7
Cost (Total)	771.83 $/h	771.83 $/h
Fuel Consumption (Total)	62.1 L/h	
Carbon Dioxide (Total)	147.3 kg/h	
Hydrocarbons (Total)	0.009 kg/h	
Carbon Monoxide (Total)	0.115 kg/h	
NOx (Total)	0.151 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 0.0 %
Number of Iterations: 3 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 80.0% 2.1% 0.0%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	446,147 veh/y	535,377 pers/y
Delay	100 veh-h/y	120 pers-h/y
Effective Stops	26,729 veh/y	32,075 pers/y
Travel Distance	452,165 veh-km/y	542,598 pers-km/y
Travel Time	9,160 veh-h/y	10,991 pers-h/y
Cost	370,479 $/y	370,479 $/y
Fuel Consumption	29,829 L/y	
Carbon Dioxide	70,707 kg/y	
Hydrocarbons	4 kg/y	
Carbon Monoxide	55 kg/y	

NOx	73 kg/y

INTERSECTION SUMMARY

▽ Site: 101 [Future Conditions Heath Street and Victoria Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Intersection Performance - Hourly Values

Performance Measure	Vehicles	Persons
Travel Speed (Average)	49.3 km/h	49.3 km/h
Travel Distance (Total)	842.8 veh-km/h	1011.4 pers-km/h
Travel Time (Total)	17.1 veh-h/h	20.5 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.99	
Travel Time Index	9.84	
Congestion Coefficient	1.01	
Demand Flows (Total)	832 veh/h	998 pers/h
Percent Heavy Vehicles (Demand)	3.7 %	
Degree of Saturation	0.226	
Practical Spare Capacity	333.6 %	
Effective Intersection Capacity	3679 veh/h	
Control Delay (Total)	0.22 veh-h/h	0.27 pers-h/h
Control Delay (Average)	1.0 sec	1.0 sec
Control Delay (Worst Lane)	11.0 sec	
Control Delay (Worst Movement)	12.4 sec	12.4 sec
Geometric Delay (Average)	0.5 sec	
Stop-Line Delay (Average)	0.4 sec	
Idling Time (Average)	0.2 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	0.2 veh	
95% Back of Queue - Distance (Worst Lane)	1.8 m	
Ave. Queue Storage Ratio (Worst Lane)	0.00	
Total Effective Stops	57 veh/h	68 pers/h
Effective Stop Rate	0.07	0.07
Proportion Queued	0.05	0.05
Performance Index	18.2	18.2
Cost (Total)	699.30 $/h	699.30 $/h
Fuel Consumption (Total)	59.0 L/h	
Carbon Dioxide (Total)	140.3 kg/h	
Hydrocarbons (Total)	0.009 kg/h	
Carbon Monoxide (Total)	0.111 kg/h	
NOx (Total)	0.200 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.

Delay Model: SIDRA Standard (Geometric Delay is included).

Queue Model: SIDRA Standard.

Site Model Variability Index (Iterations 3 to N): 0.0 %

Number of Iterations: 3 (Maximum: 10)

Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 75.3% 6.1% 0.0%

Intersection Performance - Annual Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	399,158 veh/y	478,990 pers/y
Delay	106 veh-h/y	127 pers-h/y
Effective Stops	27,175 veh/y	32,611 pers/y
Travel Distance	404,546 veh-km/y	485,456 pers-km/y
Travel Time	8,211 veh-h/y	9,853 pers-h/y
Cost	335,664 $/y	335,664 $/y
Fuel Consumption	28,319 L/y	
Carbon Dioxide	67,353 kg/y	
Hydrocarbons	4 kg/y	
Carbon Monoxide	53 kg/y	

NOx	96 kg/y

INTERSECTION SUMMARY

Site: 101 [Future Conditions Heath Street and Victoria Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	49.3 km/h	49.3 km/h
Travel Distance (Total)	1143.6 veh-km/h	1372.4 pers-km/h
Travel Time (Total)	23.2 veh-h/h	27.9 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.99	
Travel Time Index	9.83	
Congestion Coefficient	1.02	
Demand Flows (Total)	1128 veh/h	1354 pers/h
Percent Heavy Vehicles (Demand)	2.4 %	
Degree of Saturation	0.347	
Practical Spare Capacity	182.7 %	
Effective Intersection Capacity	3255 veh/h	
Control Delay (Total)	0.30 veh-h/h	0.36 pers-h/h
Control Delay (Average)	1.0 sec	1.0 sec
Control Delay (Worst Lane)	16.0 sec	
Control Delay (Worst Movement)	18.0 sec	18.0 sec
Geometric Delay (Average)	0.4 sec	
Stop-Line Delay (Average)	0.5 sec	
Idling Time (Average)	0.3 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	0.4 veh	
95% Back of Queue - Distance (Worst Lane)	3.1 m	
Ave. Queue Storage Ratio (Worst Lane)	0.00	
Total Effective Stops	69 veh/h	82 pers/h
Effective Stop Rate	0.06	0.06
Proportion Queued	0.04	0.04
Performance Index	24.0	24.0
Cost (Total)	937.74 $/h	937.74 $/h
Fuel Consumption (Total)	75.0 L/h	
Carbon Dioxide (Total)	177.6 kg/h	
Hydrocarbons (Total)	0.011 kg/h	
Carbon Monoxide (Total)	0.138 kg/h	
NOx (Total)	0.172 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 0.0 %
Number of Iterations: 3 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 85.3% 2.3% 0.0%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	541,642 veh/y	649,971 pers/y
Delay	145 veh-h/y	174 pers-h/y
Effective Stops	32,976 veh/y	39,572 pers/y
Travel Distance	548,948 veh-km/y	658,738 pers-km/y
Travel Time	11,146 veh-h/y	13,375 pers-h/y
Cost	450,116 $/y	450,116 $/y
Fuel Consumption	35,981 L/y	
Carbon Dioxide	85,242 kg/y	
Hydrocarbons	5 kg/y	
Carbon Monoxide	66 kg/y	

NOx	83 kg/y

MOVEMENT SUMMARY

▽ Site: 101 [Existing Conditions Heath Street and Victoria Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Heath Street														
1	L2	5	1	5	20.0	0.039	6.1	LOS A	0.1	1.1	0.54	0.69	0.54	44.0
3	R2	17	1	18	5.9	0.039	9.6	LOS A	0.1	1.1	0.54	0.69	0.54	44.2
Approach		22	2	23	9.1	0.039	8.8	LOS A	0.1	1.1	0.54	0.69	0.54	44.1
East: Victoria Street														
4	L2	32	0	34	0.0	0.018	4.6	LOS A	0.0	0.0	0.00	0.53	0.00	46.6
5	T1	323	7	340	2.2	0.180	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.9
Approach		355	7	374	2.0	0.180	0.5	NA	0.0	0.0	0.00	0.05	0.00	49.6
West: Victoria Street														
11	T1	237	11	249	4.6	0.147	0.2	LOS A	0.1	1.1	0.06	0.02	0.06	49.7
12	R2	10	2	11	20.0	0.147	7.2	LOS A	0.1	1.1	0.06	0.02	0.06	48.6
Approach		247	13	260	5.3	0.147	0.5	NA	0.1	1.1	0.06	0.02	0.06	49.7
All Vehicles		624	22	657	3.5	0.180	0.8	NA	0.1	1.1	0.04	0.06	0.04	49.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Existing Conditions Heath Street and Victoria Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Heath Street														
1	L2	5	0	5	0.0	0.058	6.6	LOS A	0.2	1.4	0.65	0.81	0.65	42.9
3	R2	19	0	20	0.0	0.058	12.6	LOS A	0.2	1.4	0.65	0.81	0.65	42.8
Approach		24	0	25	0.0	0.058	11.4	LOS A	0.2	1.4	0.65	0.81	0.65	42.9
East: Victoria Street														
4	L2	45	1	47	2.2	0.026	4.6	LOS A	0.0	0.0	0.00	0.53	0.00	46.6
5	T1	500	11	526	2.2	0.278	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.9
Approach		545	12	574	2.2	0.278	0.5	NA	0.0	0.0	0.00	0.04	0.00	49.6
West: Victoria Street														
11	T1	277	8	292	2.9	0.159	0.1	LOS A	0.1	0.4	0.02	0.01	0.02	49.9
12	R2	3	0	3	0.0	0.159	8.3	LOS A	0.1	0.4	0.02	0.01	0.02	49.2
Approach		280	8	295	2.9	0.159	0.2	NA	0.1	0.4	0.02	0.01	0.02	49.9
All Vehicles		849	20	894	2.4	0.278	0.7	NA	0.2	1.4	0.02	0.05	0.02	49.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Development Conditions Heath Street and Victoria Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	INPUT VOLUMES HV] veh/h	DEMAND FLOWS [Total veh/h	DEMAND FLOWS HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	95% BACK OF QUEUE Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Heath Street														
1	L2	7	2	7	28.6	0.049	6.4	LOS A	0.2	1.4	0.55	0.72	0.55	43.7
3	R2	19	2	20	10.5	0.049	10.3	LOS A	0.2	1.4	0.55	0.72	0.55	43.9
Approach		26	4	27	15.4	0.049	9.3	LOS A	0.2	1.4	0.55	0.72	0.55	43.8
East: Victoria Street														
4	L2	39	0	41	0.0	0.022	4.6	LOS A	0.0	0.0	0.00	0.53	0.00	46.6
5	T1	336	7	354	2.1	0.187	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.9
Approach		375	7	395	1.9	0.187	0.5	NA	0.0	0.0	0.00	0.05	0.00	49.6
West: Victoria Street														
11	T1	243	12	256	4.9	0.155	0.3	LOS A	0.2	1.4	0.07	0.03	0.07	49.6
12	R2	12	3	13	25.0	0.155	7.6	LOS A	0.2	1.4	0.07	0.03	0.07	48.5
Approach		255	15	268	5.9	0.155	0.6	NA	0.2	1.4	0.07	0.03	0.07	49.6
All Vehicles		656	26	691	4.0	0.187	0.9	NA	0.2	1.4	0.05	0.07	0.05	49.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Development Conditions Heath Street and Victoria Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Heath Street														
1	L2	5	0	5	0.0	0.081	6.7	LOS A	0.3	2.0	0.68	0.83	0.68	42.5
3	R2	26	0	27	0.0	0.081	13.3	LOS A	0.3	2.0	0.68	0.83	0.68	42.4
Approach		31	0	33	0.0	0.081	12.2	LOS A	0.3	2.0	0.68	0.83	0.68	42.4
East: Victoria Street														
4	L2	47	2	49	4.3	0.028	4.6	LOS A	0.0	0.0	0.00	0.53	0.00	46.6
5	T1	511	12	538	2.3	0.284	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.9
Approach		558	14	587	2.5	0.284	0.5	NA	0.0	0.0	0.00	0.04	0.00	49.6
West: Victoria Street														
11	T1	290	9	305	3.1	0.168	0.1	LOS A	0.1	0.5	0.02	0.01	0.02	49.8
12	R2	4	0	4	0.0	0.168	8.5	LOS A	0.1	0.5	0.02	0.01	0.02	49.1
Approach		294	9	309	3.1	0.168	0.2	NA	0.1	0.5	0.02	0.01	0.02	49.8
All Vehicles		883	23	929	2.6	0.284	0.8	NA	0.3	2.0	0.03	0.06	0.03	49.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Future Conditions Heath Street and Victoria Street AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Heath Street														
1	L2	7	2	7	28.6	0.065	6.9	LOS A	0.2	1.8	0.61	0.79	0.61	42.8
3	R2	21	2	22	9.5	0.065	12.4	LOS A	0.2	1.8	0.61	0.79	0.61	43.0
Approach		28	4	29	14.3	0.065	11.0	LOS A	0.2	1.8	0.61	0.79	0.61	42.9
East: Victoria Street														
4	L2	46	0	48	0.0	0.026	4.6	LOS A	0.0	0.0	0.00	0.53	0.00	46.6
5	T1	407	8	428	2.0	0.226	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.9
Approach		453	8	477	1.8	0.226	0.5	NA	0.0	0.0	0.00	0.05	0.00	49.5
West: Victoria Street														
11	T1	296	14	312	4.7	0.188	0.3	LOS A	0.2	1.8	0.07	0.02	0.07	49.6
12	R2	13	3	14	23.1	0.188	8.5	LOS A	0.2	1.8	0.07	0.02	0.07	48.5
Approach		309	17	325	5.5	0.188	0.7	NA	0.2	1.8	0.07	0.02	0.07	49.5
All Vehicles		790	29	832	3.7	0.226	1.0	NA	0.2	1.8	0.05	0.07	0.05	49.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Future Conditions Heath Street and Victoria Street PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Heath Street														
1	L2	7	0	7	0.0	0.131	7.6	LOS A	0.4	3.1	0.78	0.89	0.78	40.7
3	R2	30	0	32	0.0	0.131	18.0	LOS B	0.4	3.1	0.78	0.89	0.78	40.6
Approach		37	0	39	0.0	0.131	16.0	LOS B	0.4	3.1	0.78	0.89	0.78	40.6
East: Victoria Street														
4	L2	57	2	60	3.5	0.034	4.6	LOS A	0.0	0.0	0.00	0.53	0.00	46.6
5	T1	623	14	656	2.2	0.347	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.8
Approach		680	16	716	2.4	0.347	0.5	NA	0.0	0.0	0.00	0.04	0.00	49.5
West: Victoria Street														
11	T1	351	10	369	2.8	0.203	0.2	LOS A	0.1	0.7	0.03	0.01	0.03	49.8
12	R2	4	0	4	0.0	0.203	10.3	LOS A	0.1	0.7	0.03	0.01	0.03	49.1
Approach		355	10	374	2.8	0.203	0.3	NA	0.1	0.7	0.03	0.01	0.03	49.8
All Vehicles		1072	26	1128	2.4	0.347	1.0	NA	0.4	3.1	0.04	0.06	0.04	49.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

INTERSECTION SUMMARY

Site: 101 [Existing Conditions Richmond Road and Cox Avenue AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	47.7 km/h	47.7 km/h
Travel Distance (Total)	237.1 veh-km/h	284.5 pers-km/h
Travel Time (Total)	5.0 veh-h/h	6.0 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.95	
Travel Time Index	9.49	
Congestion Coefficient	1.05	
Demand Flows (Total)	234 veh/h	280 pers/h
Percent Heavy Vehicles (Demand)	3.6 %	
Degree of Saturation	0.078	
Practical Spare Capacity	1155.0 %	
Effective Intersection Capacity	2993 veh/h	
Control Delay (Total)	0.18 veh-h/h	0.22 pers-h/h
Control Delay (Average)	2.8 sec	2.8 sec
Control Delay (Worst Lane)	4.9 sec	
Control Delay (Worst Movement)	5.3 sec	5.3 sec
Geometric Delay (Average)	2.6 sec	
Stop-Line Delay (Average)	0.1 sec	
Idling Time (Average)	0.0 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	0.4 veh	
95% Back of Queue - Distance (Worst Lane)	2.6 m	
Ave. Queue Storage Ratio (Worst Lane)	0.00	
Total Effective Stops	68 veh/h	82 pers/h
Effective Stop Rate	0.29	0.29
Proportion Queued	0.10	0.10
Performance Index	6.0	6.0
Cost (Total)	251.63 $/h	251.63 $/h
Fuel Consumption (Total)	38.7 L/h	
Carbon Dioxide (Total)	92.1 kg/h	
Hydrocarbons (Total)	0.008 kg/h	
Carbon Monoxide (Total)	0.083 kg/h	
NOx (Total)	0.212 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 0.0 %
Number of Iterations: 3 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 26.4% 8.5% 0.0%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	112,168 veh/y	134,602 pers/y
Delay	86 veh-h/y	103 pers-h/y
Effective Stops	32,828 veh/y	39,393 pers/y
Travel Distance	113,809 veh-km/y	136,571 pers-km/y
Travel Time	2,386 veh-h/y	2,864 pers-h/y
Cost	120,785 $/y	120,785 $/y
Fuel Consumption	18,556 L/y	
Carbon Dioxide	44,188 kg/y	
Hydrocarbons	4 kg/y	
Carbon Monoxide	40 kg/y	

NOx	102 kg/y

INTERSECTION SUMMARY

▽ Site: 101 [Existing Conditions Richmond Road and Cox Avenue PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Intersection Performance - Hourly Values				
Performance Measure	**Vehicles**		**Persons**	
Travel Speed (Average)	48.0	km/h	48.0	km/h
Travel Distance (Total)	249.8	veh-km/h	299.8	pers-km/h
Travel Time (Total)	5.2	veh-h/h	6.3	pers-h/h
Desired Speed (Program)	50.0	km/h		
Speed Efficiency	0.96			
Travel Time Index	9.55			
Congestion Coefficient	1.04			
Demand Flows (Total)	246	veh/h	296	pers/h
Percent Heavy Vehicles (Demand)	2.6	%		
Degree of Saturation	0.064			
Practical Spare Capacity	1420.0	%		
Effective Intersection Capacity	3820	veh/h		
Control Delay (Total)	0.17	veh-h/h	0.20	pers-h/h
Control Delay (Average)	2.4	sec	2.4	sec
Control Delay (Worst Lane)	4.9	sec		
Control Delay (Worst Movement)	5.3	sec	5.3	sec
Geometric Delay (Average)	2.3	sec		
Stop-Line Delay (Average)	0.2	sec		
Idling Time (Average)	0.0	sec		
Intersection Level of Service (LOS)	NA			
95% Back of Queue - Vehicles (Worst Lane)	0.3	veh		
95% Back of Queue - Distance (Worst Lane)	2.0	m		
Ave. Queue Storage Ratio (Worst Lane)	0.00			
Total Effective Stops	62	veh/h	75	pers/h
Effective Stop Rate	0.25		0.25	
Proportion Queued	0.11		0.11	
Performance Index	6.1		6.1	
Cost (Total)	259.94	$/h	259.94	$/h
Fuel Consumption (Total)	38.8	L/h		
Carbon Dioxide (Total)	92.2	kg/h		
Hydrocarbons (Total)	0.008	kg/h		
Carbon Monoxide (Total)	0.086	kg/h		
NOx (Total)	0.169	kg/h		

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 0.0 %
Number of Iterations: 3 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 26.5% 8.8% 0.0%

Intersection Performance - Annual Values				
Performance Measure	**Vehicles**		**Persons**	
Demand Flows (Total)	118,232	veh/y	141,878	pers/y
Delay	80	veh-h/y	96	pers-h/y
Effective Stops	29,991	veh/y	35,989	pers/y
Travel Distance	119,916	veh-km/y	143,899	pers-km/y
Travel Time	2,500	veh-h/y	3,001	pers-h/y
Cost	124,771	$/y	124,771	$/y
Fuel Consumption	18,647	L/y		
Carbon Dioxide	44,237	kg/y		
Hydrocarbons	4	kg/y		
Carbon Monoxide	41	kg/y		

NOx	81 kg/y

INTERSECTION SUMMARY

▽ Site: 101 [Development Conditions Richmond Road and Cox Avenue AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	47.6 km/h	47.6 km/h
Travel Distance (Total)	315.1 veh-km/h	378.2 pers-km/h
Travel Time (Total)	6.6 veh-h/h	8.0 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.95	
Travel Time Index	9.46	
Congestion Coefficient	1.05	
Demand Flows (Total)	311 veh/h	373 pers/h
Percent Heavy Vehicles (Demand)	2.7 %	
Degree of Saturation	0.121	
Practical Spare Capacity	708.6 %	
Effective Intersection Capacity	2562 veh/h	
Control Delay (Total)	0.25 veh-h/h	0.31 pers-h/h
Control Delay (Average)	2.9 sec	2.9 sec
Control Delay (Worst Lane)	5.0 sec	
Control Delay (Worst Movement)	5.7 sec	5.7 sec
Geometric Delay (Average)	2.8 sec	
Stop-Line Delay (Average)	0.2 sec	
Idling Time (Average)	0.0 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	0.6 veh	
95% Back of Queue - Distance (Worst Lane)	4.3 m	
Ave. Queue Storage Ratio (Worst Lane)	0.00	
Total Effective Stops	96 veh/h	115 pers/h
Effective Stop Rate	0.31	0.31
Proportion Queued	0.12	0.12
Performance Index	8.2	8.2
Cost (Total)	329.74 $/h	329.74 $/h
Fuel Consumption (Total)	49.0 L/h	
Carbon Dioxide (Total)	116.4 kg/h	
Hydrocarbons (Total)	0.010 kg/h	
Carbon Monoxide (Total)	0.108 kg/h	
NOx (Total)	0.223 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 0.0 %
Number of Iterations: 3 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 28.4% 9.3% 0.0%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	149,053 veh/y	178,863 pers/y
Delay	122 veh-h/y	146 pers-h/y
Effective Stops	46,140 veh/y	55,368 pers/y
Travel Distance	151,262 veh-km/y	181,515 pers-km/y
Travel Time	3,180 veh-h/y	3,817 pers-h/y
Cost	158,274 $/y	158,274 $/y
Fuel Consumption	23,527 L/y	
Carbon Dioxide	55,868 kg/y	
Hydrocarbons	5 kg/y	
Carbon Monoxide	52 kg/y	

NOx	107 kg/y

INTERSECTION SUMMARY

▽ Site: 101 [Development Conditions Richmond Road and Cox Avenue PM Peak - Copy (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Intersection Performance - Hourly Values

Performance Measure	Vehicles	Persons
Travel Speed (Average)	47.6 km/h	47.6 km/h
Travel Distance (Total)	341.7 veh-km/h	410.1 pers-km/h
Travel Time (Total)	7.2 veh-h/h	8.6 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.95	
Travel Time Index	9.47	
Congestion Coefficient	1.05	
Demand Flows (Total)	337 veh/h	404 pers/h
Percent Heavy Vehicles (Demand)	2.8 %	
Degree of Saturation	0.073	
Practical Spare Capacity	1002.4 %	
Effective Intersection Capacity	4642 veh/h	
Control Delay (Total)	0.27 veh-h/h	0.32 pers-h/h
Control Delay (Average)	2.9 sec	2.9 sec
Control Delay (Worst Lane)	4.9 sec	
Control Delay (Worst Movement)	5.5 sec	5.5 sec
Geometric Delay (Average)	2.7 sec	
Stop-Line Delay (Average)	0.2 sec	
Idling Time (Average)	0.0 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	0.3 veh	
95% Back of Queue - Distance (Worst Lane)	2.3 m	
Ave. Queue Storage Ratio (Worst Lane)	0.00	
Total Effective Stops	100 veh/h	121 pers/h
Effective Stop Rate	0.30	0.30
Proportion Queued	0.13	0.13
Performance Index	8.5	8.5
Cost (Total)	358.92 $/h	358.92 $/h
Fuel Consumption (Total)	53.9 L/h	
Carbon Dioxide (Total)	127.9 kg/h	
Hydrocarbons (Total)	0.011 kg/h	
Carbon Monoxide (Total)	0.118 kg/h	
NOx (Total)	0.249 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 0.0 %
Number of Iterations: 3 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 24.7% 9.9% 0.0%

Intersection Performance - Annual Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	161,684 veh/y	194,021 pers/y
Delay	129 veh-h/y	155 pers-h/y
Effective Stops	48,228 veh/y	57,873 pers/y
Travel Distance	164,025 veh-km/y	196,830 pers-km/y
Travel Time	3,445 veh-h/y	4,134 pers-h/y
Cost	172,281 $/y	172,281 $/y
Fuel Consumption	25,860 L/y	
Carbon Dioxide	61,399 kg/y	
Hydrocarbons	5 kg/y	
Carbon Monoxide	57 kg/y	

NOx	120 kg/y

INTERSECTION SUMMARY

▽ Site: 101 [Future Conditions Richmond Road and Cox Avenue AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	48.2 km/h	48.2 km/h
Travel Distance (Total)	377.1 veh-km/h	452.5 pers-km/h
Travel Time (Total)	7.8 veh-h/h	9.4 pers-h/h
Desired Speed (Program)	50.4 km/h	
Speed Efficiency	0.96	
Travel Time Index	9.51	
Congestion Coefficient	1.05	
Demand Flows (Total)	372 veh/h	446 pers/h
Percent Heavy Vehicles (Demand)	3.1 %	
Degree of Saturation	0.143	
Practical Spare Capacity	586.4 %	
Effective Intersection Capacity	2603 veh/h	
Control Delay (Total)	0.31 veh-h/h	0.38 pers-h/h
Control Delay (Average)	3.0 sec	3.0 sec
Control Delay (Worst Lane)	5.1 sec	
Control Delay (Worst Movement)	5.9 sec	5.9 sec
Geometric Delay (Average)	2.8 sec	
Stop-Line Delay (Average)	0.2 sec	
Idling Time (Average)	0.0 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	0.7 veh	
95% Back of Queue - Distance (Worst Lane)	5.1 m	
Ave. Queue Storage Ratio (Worst Lane)	0.00	
Total Effective Stops	119 veh/h	143 pers/h
Effective Stop Rate	0.32	0.32
Proportion Queued	0.14	0.14
Performance Index	9.7	9.7
Cost (Total)	394.64 $/h	394.64 $/h
Fuel Consumption (Total)	60.1 L/h	
Carbon Dioxide (Total)	142.9 kg/h	
Hydrocarbons (Total)	0.012 kg/h	
Carbon Monoxide (Total)	0.132 kg/h	
NOx (Total)	0.299 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 0.0 %
Number of Iterations: 3 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 30.0% 10.0% 0.0%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	178,358 veh/y	214,030 pers/y
Delay	151 veh-h/y	181 pers-h/y
Effective Stops	57,093 veh/y	68,512 pers/y
Travel Distance	180,995 veh-km/y	217,194 pers-km/y
Travel Time	3,759 veh-h/y	4,511 pers-h/y
Cost	189,428 $/y	189,428 $/y
Fuel Consumption	28,858 L/y	
Carbon Dioxide	68,610 kg/y	
Hydrocarbons	6 kg/y	
Carbon Monoxide	64 kg/y	

NOx	144 kg/y

INTERSECTION SUMMARY

▽ Site: 101 [Future Conditions Richmond Road and Cox Avenue PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Travel Speed (Average)	47.6 km/h	47.6 km/h
Travel Distance (Total)	395.1 veh-km/h	474.1 pers-km/h
Travel Time (Total)	8.3 veh-h/h	10.0 pers-h/h
Desired Speed (Program)	50.0 km/h	
Speed Efficiency	0.95	
Travel Time Index	9.47	
Congestion Coefficient	1.05	
Demand Flows (Total)	389 veh/h	467 pers/h
Percent Heavy Vehicles (Demand)	2.4 %	
Degree of Saturation	0.084	
Practical Spare Capacity	881.9 %	
Effective Intersection Capacity	4659 veh/h	
Control Delay (Total)	0.31 veh-h/h	0.37 pers-h/h
Control Delay (Average)	2.9 sec	2.9 sec
Control Delay (Worst Lane)	5.0 sec	
Control Delay (Worst Movement)	5.7 sec	5.7 sec
Geometric Delay (Average)	2.6 sec	
Stop-Line Delay (Average)	0.3 sec	
Idling Time (Average)	0.0 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	0.4 veh	
95% Back of Queue - Distance (Worst Lane)	2.7 m	
Ave. Queue Storage Ratio (Worst Lane)	0.00	
Total Effective Stops	115 veh/h	138 pers/h
Effective Stop Rate	0.29	0.29
Proportion Queued	0.14	0.14
Performance Index	9.9	9.9
Cost (Total)	412.36 $/h	412.36 $/h
Fuel Consumption (Total)	61.2 L/h	
Carbon Dioxide (Total)	145.0 kg/h	
Hydrocarbons (Total)	0.012 kg/h	
Carbon Monoxide (Total)	0.136 kg/h	
NOx (Total)	0.257 kg/h	

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Site Model Variability Index (Iterations 3 to N): 0.0 %
Number of Iterations: 3 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 26.3% 10.7% 0.0%

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	186,947 veh/y	224,337 pers/y
Delay	149 veh-h/y	179 pers-h/y
Effective Stops	55,148 veh/y	66,178 pers/y
Travel Distance	189,648 veh-km/y	227,578 pers-km/y
Travel Time	3,982 veh-h/y	4,779 pers-h/y
Cost	197,934 $/y	197,934 $/y
Fuel Consumption	29,352 L/y	
Carbon Dioxide	69,601 kg/y	
Hydrocarbons	6 kg/y	
Carbon Monoxide	65 kg/y	

NOx	124 kg/y

MOVEMENT SUMMARY

▽ Site: 101 [Existing Conditions Richmond Road and Cox Avenue AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Richmond Road														
1	L2	23	0	24	0.0	0.031	4.6	LOS A	0.0	0.0	0.00	0.21	0.00	48.4
2	T1	37	0	39	0.0	0.031	0.0	LOS A	0.0	0.0	0.00	0.21	0.00	48.8
Approach		60	0	63	0.0	0.031	1.8	NA	0.0	0.0	0.00	0.21	0.00	48.6
North: Richmond Road														
8	T1	58	3	61	5.2	0.078	0.2	LOS A	0.4	2.6	0.15	0.28	0.15	47.9
9	R2	75	2	79	2.7	0.078	4.8	LOS A	0.4	2.6	0.15	0.28	0.15	47.5
Approach		133	5	140	3.8	0.078	2.7	NA	0.4	2.6	0.15	0.28	0.15	47.6
West: Cox Avenue														
10	L2	21	3	22	14.3	0.023	4.8	LOS A	0.1	0.7	0.11	0.50	0.11	45.9
12	R2	8	0	8	0.0	0.023	5.3	LOS A	0.1	0.7	0.11	0.50	0.11	46.4
Approach		29	3	31	10.3	0.023	4.9	LOS A	0.1	0.7	0.11	0.50	0.11	46.0
All Vehicles		222	8	234	3.6	0.078	2.8	NA	0.4	2.6	0.10	0.29	0.10	47.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Existing Conditions Richmond Road and Cox Avenue PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Richmond Road														
1	L2	19	0	20	0.0	0.041	4.6	LOS A	0.0	0.0	0.00	0.13	0.00	48.8
2	T1	61	0	64	0.0	0.041	0.0	LOS A	0.0	0.0	0.00	0.13	0.00	49.3
Approach		80	0	84	0.0	0.041	1.1	NA	0.0	0.0	0.00	0.13	0.00	49.1
North: Richmond Road														
8	T1	57	2	60	3.5	0.064	0.2	LOS A	0.3	2.0	0.16	0.24	0.16	48.1
9	R2	53	2	56	3.8	0.064	4.8	LOS A	0.3	2.0	0.16	0.24	0.16	47.6
Approach		110	4	116	3.6	0.064	2.4	NA	0.3	2.0	0.16	0.24	0.16	47.9
West: Cox Avenue														
10	L2	35	2	37	5.7	0.033	4.8	LOS A	0.1	1.0	0.16	0.50	0.16	46.1
12	R2	9	0	9	0.0	0.033	5.3	LOS A	0.1	1.0	0.16	0.50	0.16	46.3
Approach		44	2	46	4.5	0.033	4.9	LOS A	0.1	1.0	0.16	0.50	0.16	46.1
All Vehicles		234	6	246	2.6	0.064	2.4	NA	0.3	2.0	0.11	0.25	0.11	48.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Development Conditions Richmond Road and Cox Avenue AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Richmond Road														
1	L2	23	0	24	0.0	0.031	4.6	LOS A	0.0	0.0	0.00	0.21	0.00	48.4
2	T1	37	0	39	0.0	0.031	0.0	LOS A	0.0	0.0	0.00	0.21	0.00	48.8
Approach		60	0	63	0.0	0.031	1.8	NA	0.0	0.0	0.00	0.21	0.00	48.6
North: Richmond Road														
8	T1	79	3	83	3.8	0.121	0.2	LOS A	0.6	4.3	0.16	0.31	0.16	47.7
9	R2	127	2	134	1.6	0.121	4.8	LOS A	0.6	4.3	0.16	0.31	0.16	47.3
Approach		206	5	217	2.4	0.121	3.0	NA	0.6	4.3	0.16	0.31	0.16	47.5
West: Cox Avenue														
10	L2	21	3	22	14.3	0.024	4.8	LOS A	0.1	0.7	0.11	0.51	0.11	45.9
12	R2	8	0	8	0.0	0.024	5.7	LOS A	0.1	0.7	0.11	0.51	0.11	46.4
Approach		29	3	31	10.3	0.024	5.0	LOS A	0.1	0.7	0.11	0.51	0.11	46.1
All Vehicles		295	8	311	2.7	0.121	2.9	NA	0.6	4.3	0.12	0.31	0.12	47.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Development Conditions Richmond Road and Cox Avenue PM Peak - Copy (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Richmond Road														
1	L2	31	0	33	0.0	0.054	4.6	LOS A	0.0	0.0	0.00	0.16	0.00	48.6
2	T1	74	0	78	0.0	0.054	0.0	LOS A	0.0	0.0	0.00	0.16	0.00	49.1
Approach		105	0	111	0.0	0.054	1.4	NA	0.0	0.0	0.00	0.16	0.00	48.9
North: Richmond Road														
8	T1	60	3	63	5.0	0.070	0.3	LOS A	0.3	2.2	0.19	0.25	0.19	48.0
9	R2	56	3	59	5.4	0.070	4.9	LOS A	0.3	2.2	0.19	0.25	0.19	47.5
Approach		116	6	122	5.2	0.070	2.5	NA	0.3	2.2	0.19	0.25	0.19	47.8
West: Cox Avenue														
10	L2	89	3	94	3.4	0.073	4.8	LOS A	0.3	2.3	0.18	0.50	0.18	46.1
12	R2	10	0	11	0.0	0.073	5.5	LOS A	0.3	2.3	0.18	0.50	0.18	46.3
Approach		99	3	104	3.0	0.073	4.9	LOS A	0.3	2.3	0.18	0.50	0.18	46.1
All Vehicles		320	9	337	2.8	0.073	2.9	NA	0.3	2.3	0.13	0.30	0.13	47.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Future Conditions Richmond Road and Cox Avenue AM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Richmond Road														
1	L2	29	0	31	0.0	0.039	4.9	LOS A	0.0	0.0	0.00	0.26	0.00	51.0
2	T1	47	0	49	0.0	0.039	0.4	LOS A	0.0	0.0	0.00	0.26	0.00	52.4
Approach		76	0	80	0.0	0.039	2.1	NA	0.0	0.0	0.00	0.26	0.00	51.9
North: Richmond Road														
8	T1	94	4	99	4.3	0.143	0.2	LOS A	0.7	5.1	0.18	0.31	0.18	47.7
9	R2	146	3	154	2.1	0.143	4.8	LOS A	0.7	5.1	0.18	0.31	0.18	47.3
Approach		240	7	253	2.9	0.143	3.0	NA	0.7	5.1	0.18	0.31	0.18	47.4
West: Cox Avenue														
10	L2	27	4	28	14.8	0.031	4.8	LOS A	0.1	0.9	0.13	0.51	0.13	45.8
12	R2	10	0	11	0.0	0.031	5.9	LOS A	0.1	0.9	0.13	0.51	0.13	46.4
Approach		37	4	39	10.8	0.031	5.1	LOS A	0.1	0.9	0.13	0.51	0.13	46.0
All Vehicles		353	11	372	3.1	0.143	3.0	NA	0.7	5.1	0.14	0.32	0.14	48.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Future Conditions Richmond Road and Cox Avenue PM Peak (Site Folder: General)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Richmond Road														
1	L2	35	0	37	0.0	0.063	4.6	LOS A	0.0	0.0	0.00	0.16	0.00	48.6
2	T1	87	0	92	0.0	0.063	0.0	LOS A	0.0	0.0	0.00	0.16	0.00	49.1
Approach		122	0	128	0.0	0.063	1.3	NA	0.0	0.0	0.00	0.16	0.00	49.0
North: Richmond Road														
8	T1	72	3	76	4.2	0.084	0.3	LOS A	0.4	2.7	0.21	0.25	0.21	48.0
9	R2	67	3	71	4.5	0.084	5.0	LOS A	0.4	2.7	0.21	0.25	0.21	47.5
Approach		139	6	146	4.3	0.084	2.6	NA	0.4	2.7	0.21	0.25	0.21	47.7
West: Cox Avenue														
10	L2	97	3	102	3.1	0.081	4.9	LOS A	0.4	2.5	0.20	0.51	0.20	46.0
12	R2	12	0	13	0.0	0.081	5.7	LOS A	0.4	2.5	0.20	0.51	0.20	46.2
Approach		109	3	115	2.8	0.081	5.0	LOS A	0.4	2.5	0.20	0.51	0.20	46.1
All Vehicles		370	9	389	2.4	0.084	2.9	NA	0.4	2.7	0.14	0.29	0.14	47.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Appendix C Parking Survey Results

Client	Northrop Consulting Engineers
Date	Thu, 5th May 2022
Description	Kingswood Parking Survey

Street Name	Side of Street	Between	Restriction	Applicable Hours	Supply	6:00	7:00	8:00	9:00	10:00
1. Cox Ave	South	Richomond Rd & Phillip St	No Restriction		**8**	0	1	3	3	3
			No Restriction		**8**	2	2	2	2	5
			No Restriction		**8**	0	2	2	7	6
			No Restriction		**14**	2	7	10	13	12
			No Restriction		**8**	7	8	7	8	7
	North	Richomond Rd & Phillip St	No Stopping							
			Bus Zone		**3**	0	0	0	0	0
			No Restriction		**23**	14	14	14	20	18
			No Stopping							
			No Restriction		**26**	17	19	24	23	23
Total					**98**	**42**	**53**	**62**	**76**	**74**
% Capacity						**43%**	**54%**	**63%**	**78%**	**76%**
2. Phillip St	West	Cox Ave & Copeland St	No Restriction		**11**	6	7	8	7	10
	East	Copeland St & Cox Ave	No Restriction		**18**	13	16	16	17	17
Total					**29**	**19**	**23**	**24**	**24**	**27**
% Capacity						**66%**	**79%**	**83%**	**83%**	**93%**
3. Copeland St	South	Phillip St & Richomond Rd	No Restriction		**32**	3	24	25	26	23
	North	Phillip St & Richomond Rd	No Restriction		**23**	6	10	13	14	16
Total					**55**	**9**	**34**	**38**	**40**	**39**
% Capacity						**16%**	**62%**	**69%**	**73%**	**71%**
4. Richomond Rd	East	Copeland St & Joseph St	No Stopping							
		Joseph St & Cox Ave	No Stopping							
			Bus Zone	8am-9:30am, 2:30pm-4pm School days	**7**	0	0	0	0	0
			No Parking							
			No Restriction		**9**	1	4	2	5	3
	West	Cox Ave & Copeland St	No Stopping							
			No Restriction		**10**	0	3	4	2	3
			No Stopping							
Total					**26**	**1**	**7**	**6**	**7**	**6**
% Capacity						**4%**	**27%**	**23%**	**27%**	**23%**
			No Stopping							

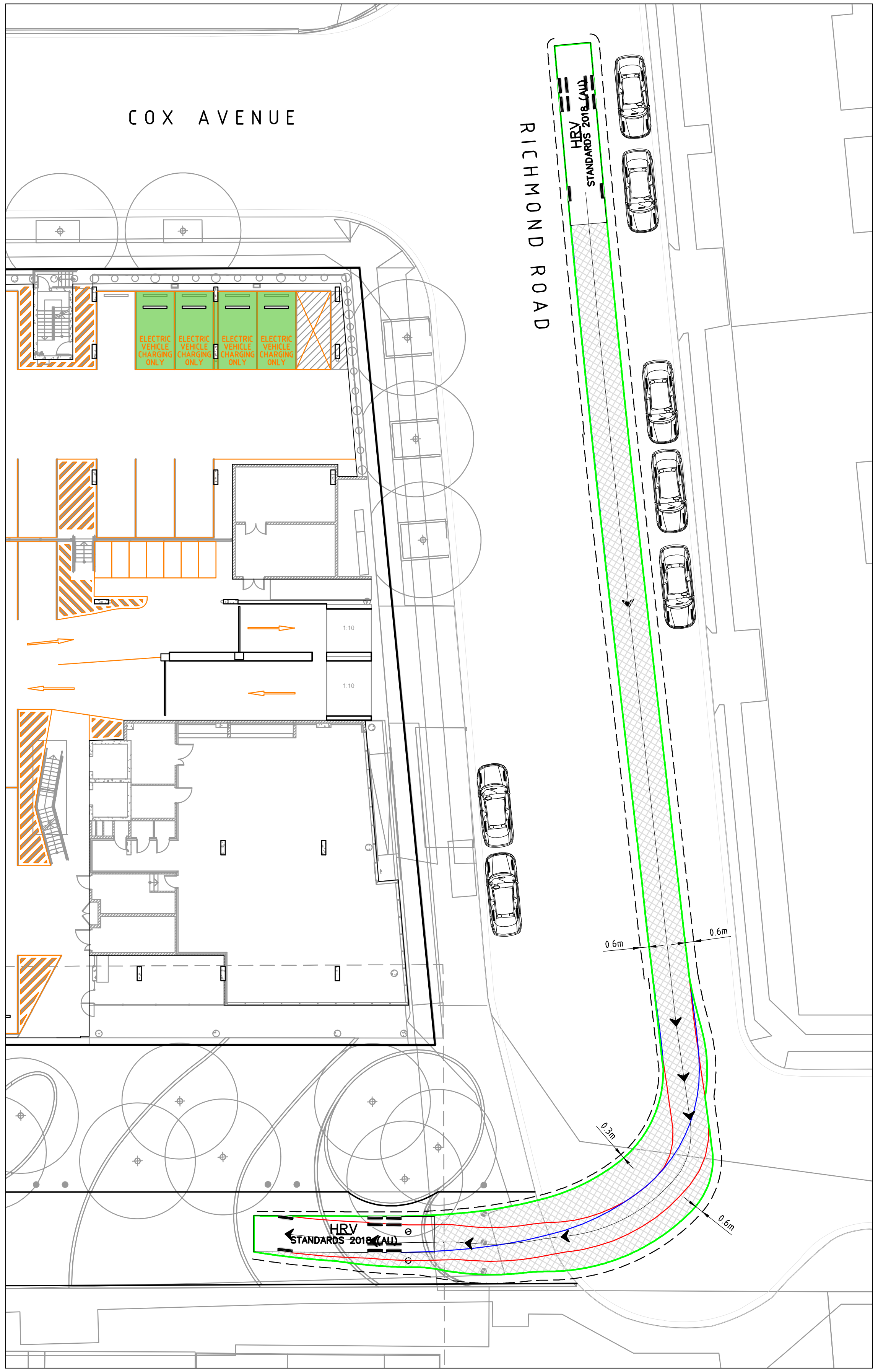
5. Park Ave	North	Richomond Rd & Walter St	Bus Zone							
			No Restriction		**74**	22	19	15	21	20
	South	Walter St & Richomond Rd	No Restriction		**93**	8	7	5	9	14
			Bus Zone							
Total					**167**	**30**	**26**	**20**	**30**	**34**
% Capacity						**18%**	**16%**	**12%**	**18%**	**20%**
6. Walter St	West	Park Ave & Walter St(Opp to Amaroo St)	No Restriction		**18**	0	0	0	0	0
		Walter St(Opp to Amaroo St) & Joseph St	No Restriction		**11**	3	2	2	2	2
	East	Joseph St & Amaroo St	No Restriction		**9**	2	2	3	2	2
		Amaroo St & Park Ave	No Restriction		**15**	0	0	0	0	0
Total					**53**	**5**	**4**	**5**	**4**	**4**
% Capacity						**9%**	**8%**	**9%**	**8%**	**8%**
7. Joseph St	South	Walter St & Richomond Rd	No Restriction		**52**	9	11	13	12	15
			No Stopping							
			No Parking	8am-9:30am, 2:30pm-4pm School days	**21**	1	1	2	1	3
			No Stopping							
	North	Richomond Rd & Walter St	No Restriction		**11**	7	6	8	8	10
			No Stopping							
			No Restriction		**37**	6	4	8	7	9
Total					**121**	**23**	**22**	**31**	**28**	**37**
% Capacity						**19%**	**18%**	**26%**	**23%**	**31%**
8. Bringelly Rd	East	Great Western Hwy & Santley Cres	No Stopping							
			1/2P	8:30am-6pm Mon-Fri, 8:30am-12:30pm Sat	**14**	1	2	1	1	2
			No Stopping							
		Santley Cres & Bringelly La	No Stopping							
			1P	8:30am-6pm Mon-Fri, 8:30am-12:30pm Sat	**7**	1	1	0	0	0
			No Parking							
		Bringelly La & Opp to Orth St	No Parking							
			1P	8:30am-6pm Mon-Fri, 8:30am-12:30pm Sat	**1**	0	0	0	0	1
			No Stopping							
			1P	8:30am-6pm Mon-Fri, 8:30am-12:30pm Sat	**4**	3	4	3	3	2
	Wes	Orth St & Rodgers St	No Stopping							
			P	Aus Post	**1**	0	0	0	0	0
			1/2P	8:30am-6pm Mon-Fri, 8:30am-12:30pm Sat	**12**	0	0	0	1	2
			No Stopping							
		Rodgers St & Wainwright Ln	No Stopping							
			1/2P	8:30am-6pm Mon-Fri, 8:30am-12:30pm Sat	**4**	0	0	1	1	1

			No Stopping							
		Wainwright Ln & Great Western Hwy	No Stopping							
Total					**43**	**5**	**7**	**5**	**6**	**8**
% Capacity						**12%**	**16%**	**12%**	**14%**	**19%**
9. Orth St	South	Bringelly Rd & Somerset St	No Stopping							
			2P	8:30am-6pm Mon-Fri	**9**	2	4	7	9	5
			No Restriction		**34**	34	34	34	34	33
			No Parking							
			No Stopping							
	North	Somerset St & Bringelly Rd	Work Zone		**8**	0	0	0	0	1
			No Restriction		**33**	31	31	31	32	33
			No Parking							
			No Stopping							
			1/2P	8:30am-6pm Mon-Fri	**8**	0	0	4	4	3
			No Stopping							
Total					**92**	**67**	**69**	**76**	**79**	**75**
% Capacity						**73%**	**75%**	**83%**	**86%**	**82%**
10. Rodgers St	South	Bringelly Rd & Somerset St	No Stopping							
			No Restriction		**32**	32	32	31	32	31
			Work Zone		**4**	0	0	0	0	0
			No Restriction		**7**	7	7	7	7	7
			No Stopping							
	North	Somerset St & Bringelly Rd	No Stopping							
			No Restriction		**52**	52	52	52	52	52
			No Stopping							
Total					**95**	**91**	**91**	**90**	**91**	**90**
% Capacity						**96%**	**96%**	**95%**	**96%**	**95%**
11. Wainwright Ln	South	Bringelly Rd & Somerset St	No Stopping							
	North	Somerset St & Bringelly Rd	No Stopping							
			No Restriction		**13**	10	10	1	11	12
			No Parking	Waste Collection and Removalist Vehicle Excepted	**3**	0	0	0	0	0
			No Stopping							
			No Restriction		**26**	10	12	13	21	20
			No Stopping							
Total					**42**	**20**	**22**	**14**	**32**	**32**
% Capacity						**48%**	**52%**	**33%**	**76%**	**76%**
			No Stopping							

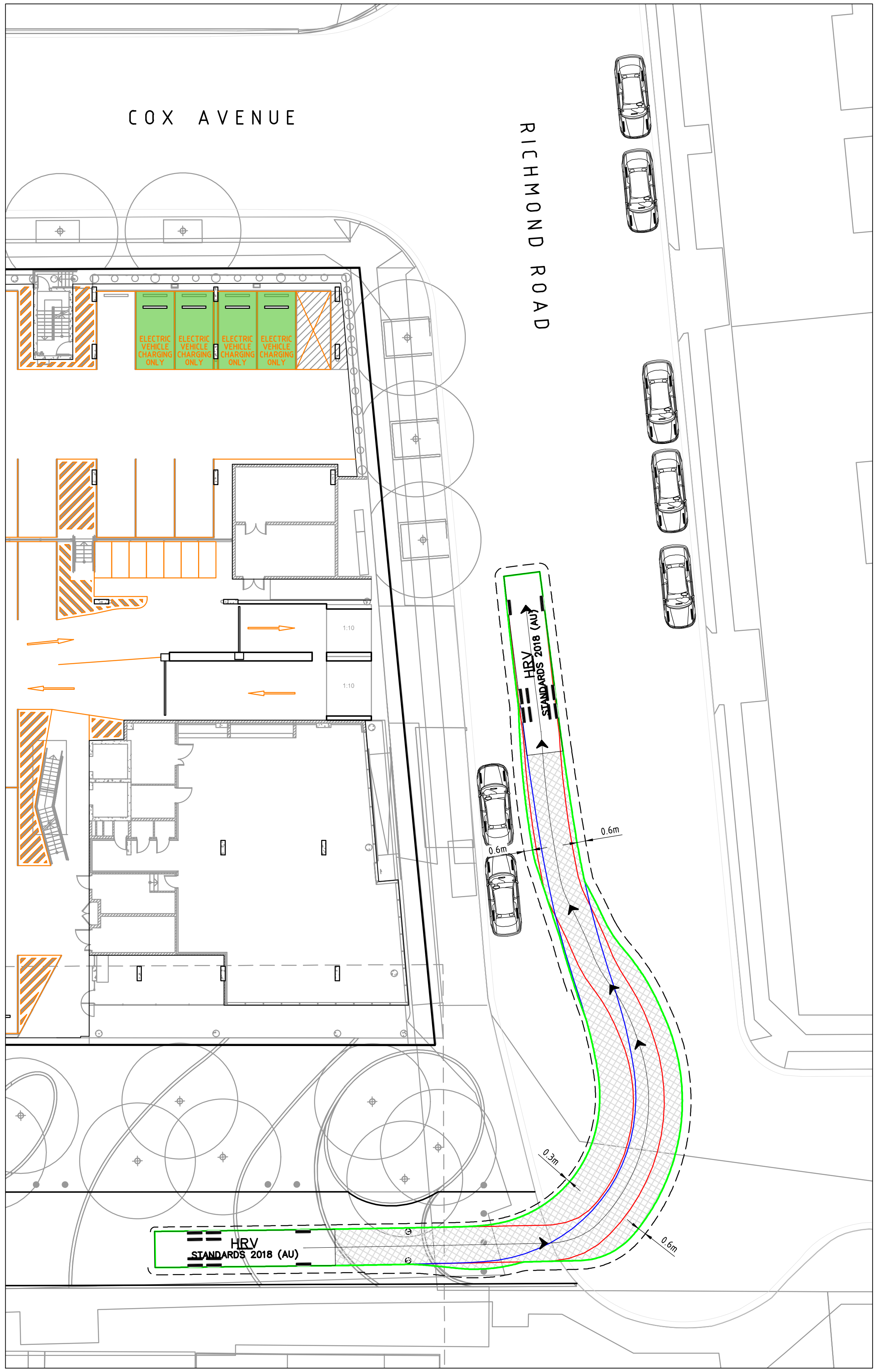
12. Somerset St	East	Great Western Hwy & Wainwright Ln	4P		**4**	2	3	3	3	3
			No Stopping							
		Wainwright Ln & Rodgers St	No Stopping							
			4P		**6**	4	5	5	5	6
			No Stopping							
		Rodgers St & Orth St	No Stopping							
			4P		**9**	7	7	9	9	9
			No Stopping							
			4P		**3**	3	3	3	3	3
			No Stopping							
	West	Opp to Orth St & Great Western Hwy	Work Zone		**20**	0	0	11	11	10
			2P		**2**	0	1	2	2	2
			No Stopping							
			2P		**5**	2	2	4	4	5
			No Stopping							
Total					**49**	**18**	**21**	**37**	**37**	**38**
% Capacity						**37%**	**43%**	**76%**	**76%**	**78%**
13. Great Western Hwy	North	Opp to Somerset St & Opp to Santley Cres	No Restriction		**11**	1	0	0	2	2
			1P	8:30am-6pm Mon-Fri, 8:30am-12:30pm Sat	**29**	0	0	0	4	3
			No Stopping							
			1P	8:30am-6pm Mon-Fri, 8:30am-12:30pm Sat	**8**	1	2	2	1	1
			No Stopping							
			Bus Zone							
			No Restriction		**52**	5	6	6	9	8
	South	Santley Cres & Bringelly Rd	No Stopping							
			No Restriction		**42**	5	5	5	7	7
			No Stopping							
			Bus Zone							
			No Stopping							
		Bringelly Rd & Somerset St	No Stopping							
			1/2P	8:30am-6pm Mon-Fri, 8:30am-12:30pm Sat	**6**	1	2	3	2	3
			No Parking							
			1/2P	8:30am-6pm Mon-Fri, 8:30am-12:30pm Sat	**57**	7	9	10	10	13
			No Stopping							
Total					**205**	**20**	**24**	**26**	**35**	**37**
% Capacity						**10%**	**12%**	**13%**	**17%**	**18%**
			No Stopping							

14. Santley Cres	North	Bringelly Rd & Santley Cres	No Restriction		**37**	14	14	14	14	17
			No Stopping							
	West	Santley Cres & Great Western Hwy	No Stopping							
			No Restriction		**13**	8	8	8	8	8
	East	Great Western Hwy & Santley Cres	No Restriction		**13**	7	8	7	8	9
	South	Santley Cres & First St	No Stopping							
			No Restriction		**33**	7	9	9	9	9
		First St & Bringelly Rd	No Stopping							
			No Restriction		**14**	5	5	5	5	5
Total					**110**	**41**	**44**	**43**	**44**	**48**
% Capacity						**37%**	**40%**	**39%**	**40%**	**44%**
Off St_A			No Restriction		**72**	19	30	39	42	42
			Disabled		**3**	1	2	2	2	2
Total					**75**	**20**	**32**	**41**	**44**	**44**
% Capacity						**27%**	**43%**	**55%**	**59%**	**59%**
Off St_B			No Restriction	8:30am-6pm Mon-Fri, 8:30am-4:30pm Sat	**114**	31	45	93	104	109
Total					**114**	**31**	**45**	**93**	**104**	**109**
% Capacity						**27%**	**39%**	**82%**	**91%**	**96%**
Off St_C			P	Small Car only	**1**	0	0	1	1	1
			Disabled		**2**	1	1	1	1	2
			No Restriction		**63**	11	29	33	47	59
			Taxi Zone		**1**	0	0	0	1	0
			P	Motorcyle Parking	**6**	0	0	0	0	1
Total					**73**	**12**	**30**	**35**	**50**	**63**
% Capacity						**16%**	**41%**	**48%**	**68%**	**86%**

Appendix D Swept Paths and Traffic Control Device Plans



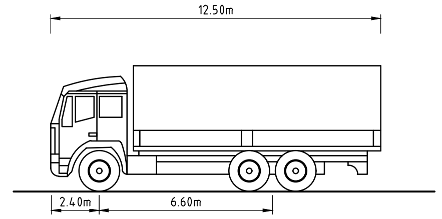
12.5m HRV APPROACHING SHAREWAY FROM RICHMOND ROAD



12.5m HRV LEAVING SHAREWAY TO RICHMOND ROAD

LEGEND

- DENOTES FRONT WHEEL PATH
- DENOTES REAR WHEEL PATH
- DENOTES VEHICLE BODY OVER HANG
- DENOTES VEHICLE BODY OFFSET IN ACCORDANCE WITH AS2890.2



A2890.2 - HEAVY RIGID VEHICLE

NOT TO SCALE

WIDTH	2.50m
TRACK	2.50m
LOCK TO LOCK TIME	6.0s
STEERING ANGLE	35.2°

NOTES:
- TfNSW TO DETERMINE TRUCK TURNING PATHS WHEN INSIDE AND BEYOND THE SHAREWAY.
- TfNSW TO CONFIRM SIZE OF DESIGN VEHICLE.

VERIFIER:
JOB MANAGER:
DESIGNED: N.GRINTER
DRAWN: B.CASTLE

NOT FOR CONSTRUCTION

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	PRELIMINARY	BC		NG	27.06.22
2	PRELIMINARY	RC		NG	28.06.22
3	PRELIMINARY	BC		NG	06.07.22

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0 2 4 6 8 10m

PLAN
SCALE 1:200 @ A1

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Canberra
Level 6, 224 Bunda Street (PO Box 213) Canberra ACT 2608
Ph (02) 6285 1822 Fax (02) 6285 1863
Email canberra@northrop.com.au ABN 81 094 433 100

PROJECT
KINGSWOOD COMMUTER CARPARK RICHMOND ROAD AND COX AVENUE

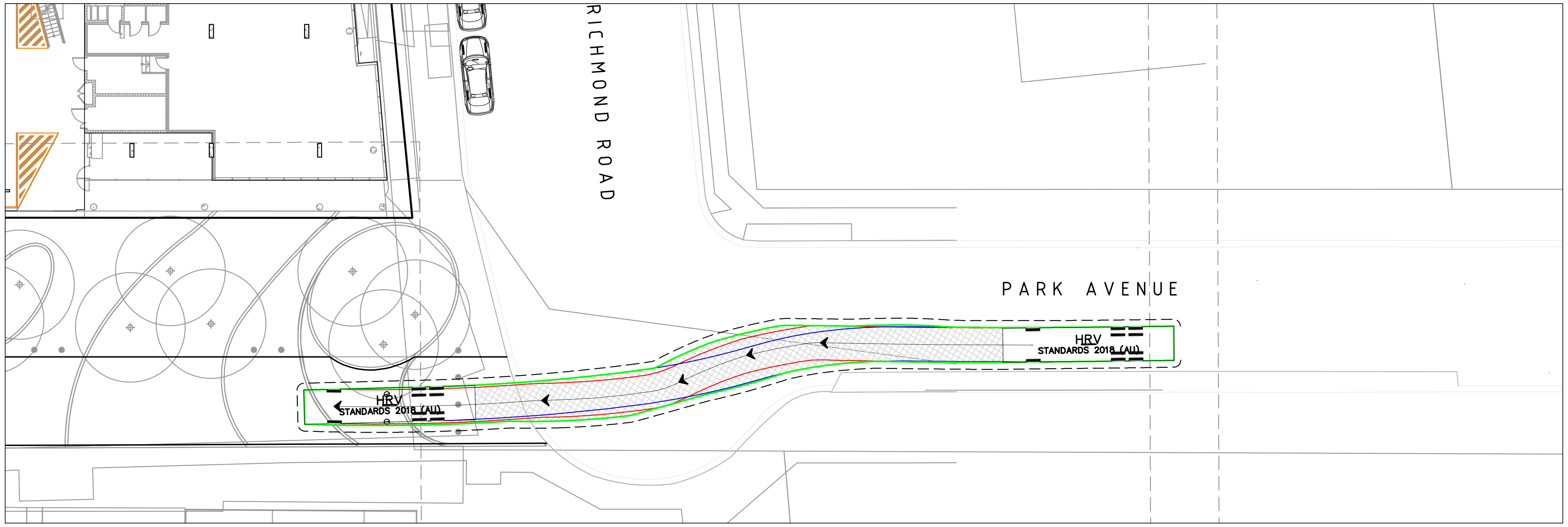
DRAWING TITLE
CIVIL WORKS VEHICLE TURNING MOVEMENTS LOWER GROUND LEVEL 12.5m HRV SHEET 1 OF 2

JOB NUMBER **210295**

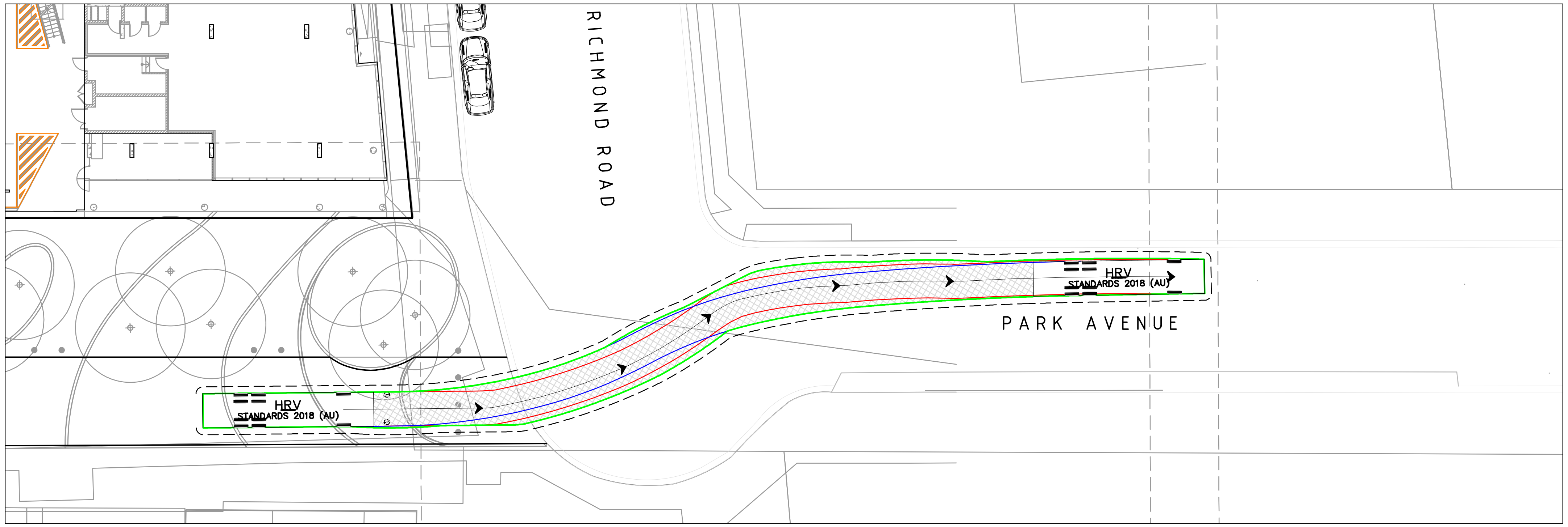
DRAWING NUMBER **C035**

REVISION **3**

DRAWING SHEET SIZE = A1



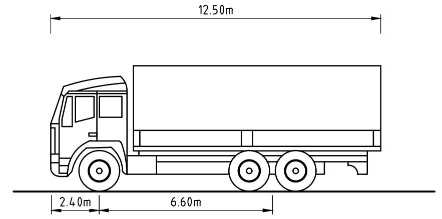
12.5m HRV APPROACHING SHAREWAY FROM PARK AVENUE



12.5m HRV LEAVING SHAREWAY TO PARK AVENUE

LEGEND

- DENOTES FRONT WHEEL PATH
- DENOTES REAR WHEEL PATH
- DENOTES VEHICLE BODY OVER HANG
- DENOTES 500mm VEHICLE BODY OFFSET



A2890.2 - HEAVY RIGID VEHICLE

NOT TO SCALE

WIDTH	2.50m
TRACK	2.50m
LOCK TO LOCK TIME	6.0s
STEERING ANGLE	35.2°

NOTES:
- TfNSW TO DETERMINE TRUCK TURNING PATHS WHEN INSIDE AND BEYOND THE SHAREWAY.
- TfNSW TO CONFIRM SIZE OF DESIGN VEHICLE.

VERIFIER:

JOB MANAGER:

DESIGNED: N.GRINTER

DRAWN: B.CASTLE

NOT FOR CONSTRUCTION

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	PRELIMINARY	BC		NG	27.06.22
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ARCHITECT: sam crawford architects

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0 2 4 6 8 10m

PLAN

SCALE 1:200 @ A1

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PROJECT: KINGSWOOD COMMUTER CARPARK RICHMOND ROAD AND COX AVENUE

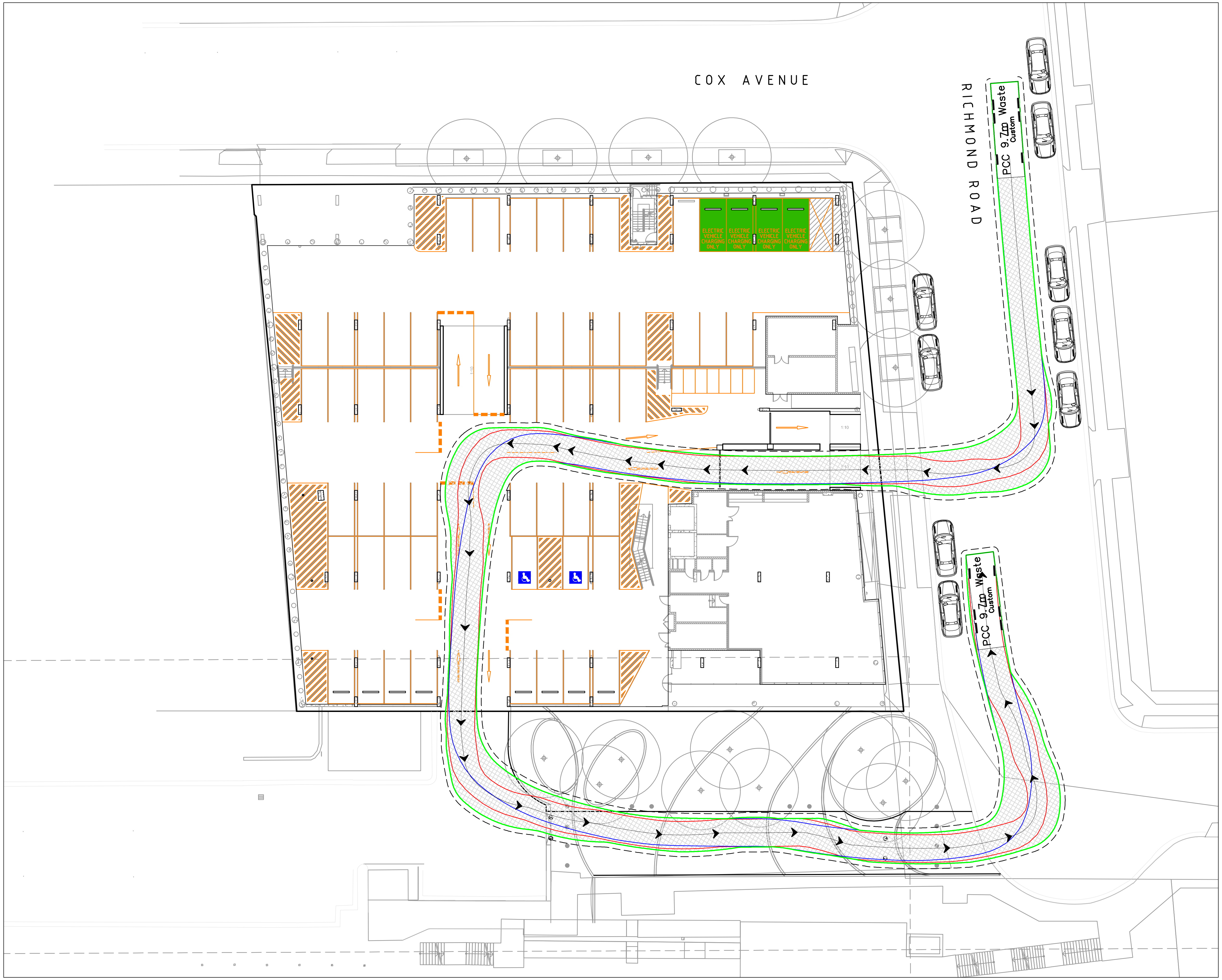
DRAWING TITLE: CIVIL WORKS VEHICLE TURNING MOVEMENTS LOWER GROUND LEVEL 12.5m HRV SHEET 2 OF 2

JOB NUMBER: 210295

DRAWING NUMBER: C036

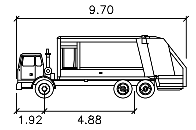
REVISION: 3

DRAWING SHEET SIZE = A1



LEGEND

DENOTES FRONT WHEEL PATH
DENOTES REAR WHEEL PATH
DENOTES VEHICLE BODY OVER HANG
DENOTES 500mm VEHICLE BODY OFFSET



PCC 9.7m Waste

	meters
Width	: 2.80
Track	: 2.80
Lock to Lock Time	: 6.0
Steering Angle	: 50.0

NOT FOR CONSTRUCTION

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	PRELIMINARY	BC		NG	27.06.22
2	PRELIMINARY	BC		NG	06.07.22

DRAWN: B.CASTLE
DESIGNED: N.GRINTER
JOB MANAGER:
VERIFIER:

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ARCHITECT: sam crawford architects

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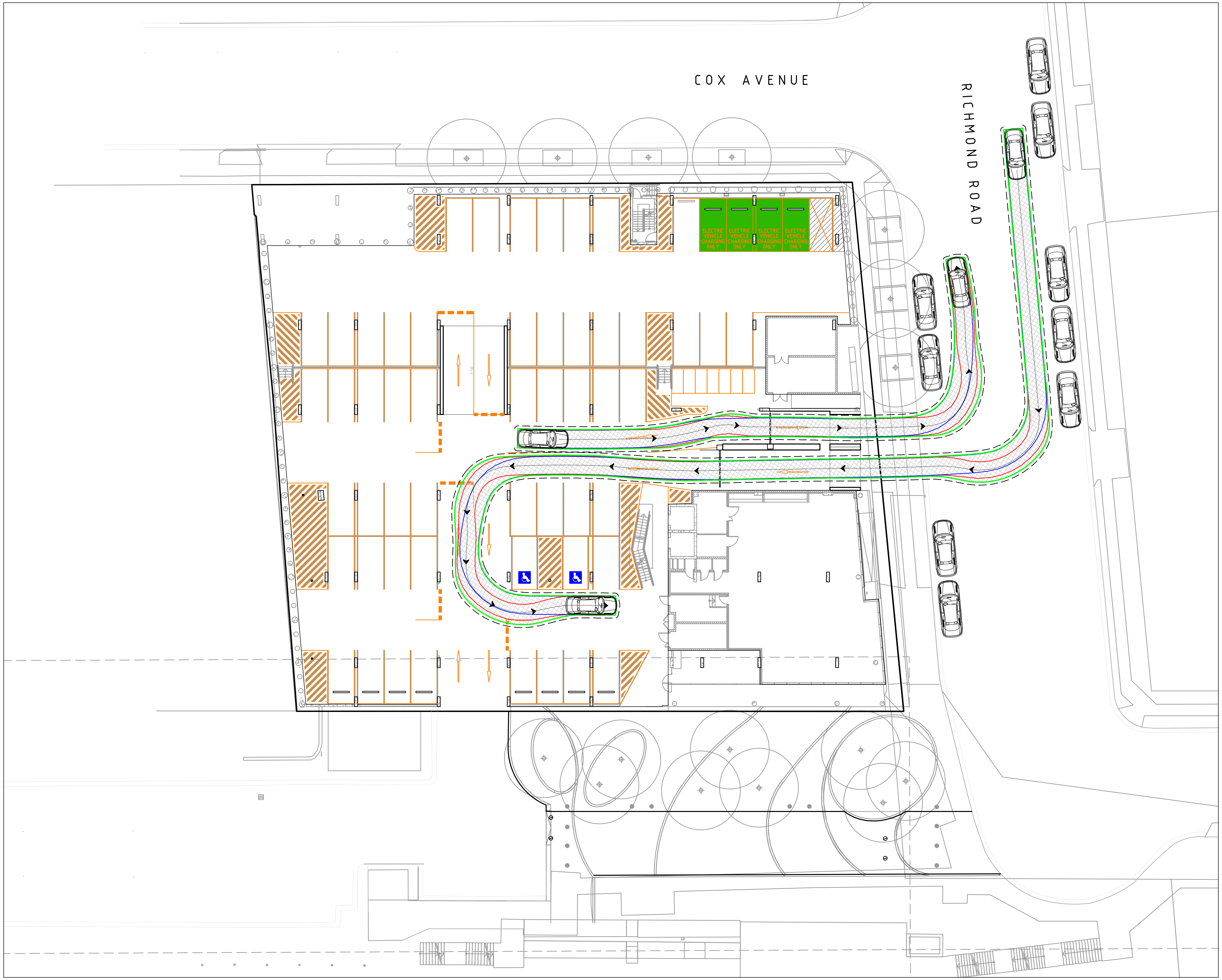
Email canberra@northrop.com.au ABN 81 094 433 100

PROJECT: KINGSWOOD COMMUTER CARPARK RICHMOND ROAD AND COX AVENUE

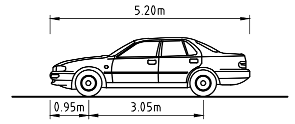
DRAWING TITLE: CIVIL WORKS VEHICLE TURNING MOVEMENTS LOWER GROUND LEVEL 9.7m WASTE TRUCK

JOB NUMBER: 210295
DRAWING NUMBER: C040
REVISION: 2
DRAWING SHEET SIZE = A1



LEGEND

(red line)	DENOTES FRONT WHEEL PATH
(blue line)	DENOTES REAR WHEEL PATH
(green hatched box)	DENOTES VEHICLE BODY OVER HANG
(dashed line)	DENOTES 300mm VEHICLE BODY OFFSET



AS2890.1 – B99 CAR

NOT TO SCALE

WIDTH	1.94m
TRACK	1.84m
LOCK TO LOCK TIME	6.0s
STEERING ANGLE	33.9°

VERIFIER:
JOB MANAGER:
DESIGNED: N.GRINTER
DRAWN: B.CASTLE

NOT FOR CONSTRUCTION

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
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2	PRELIMINARY	BC		NG	06.07.22

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PROJECT

KINGSWOOD COMMUTER CARPARK RICHMOND ROAD AND COX AVENUE

DRAWING TITLE

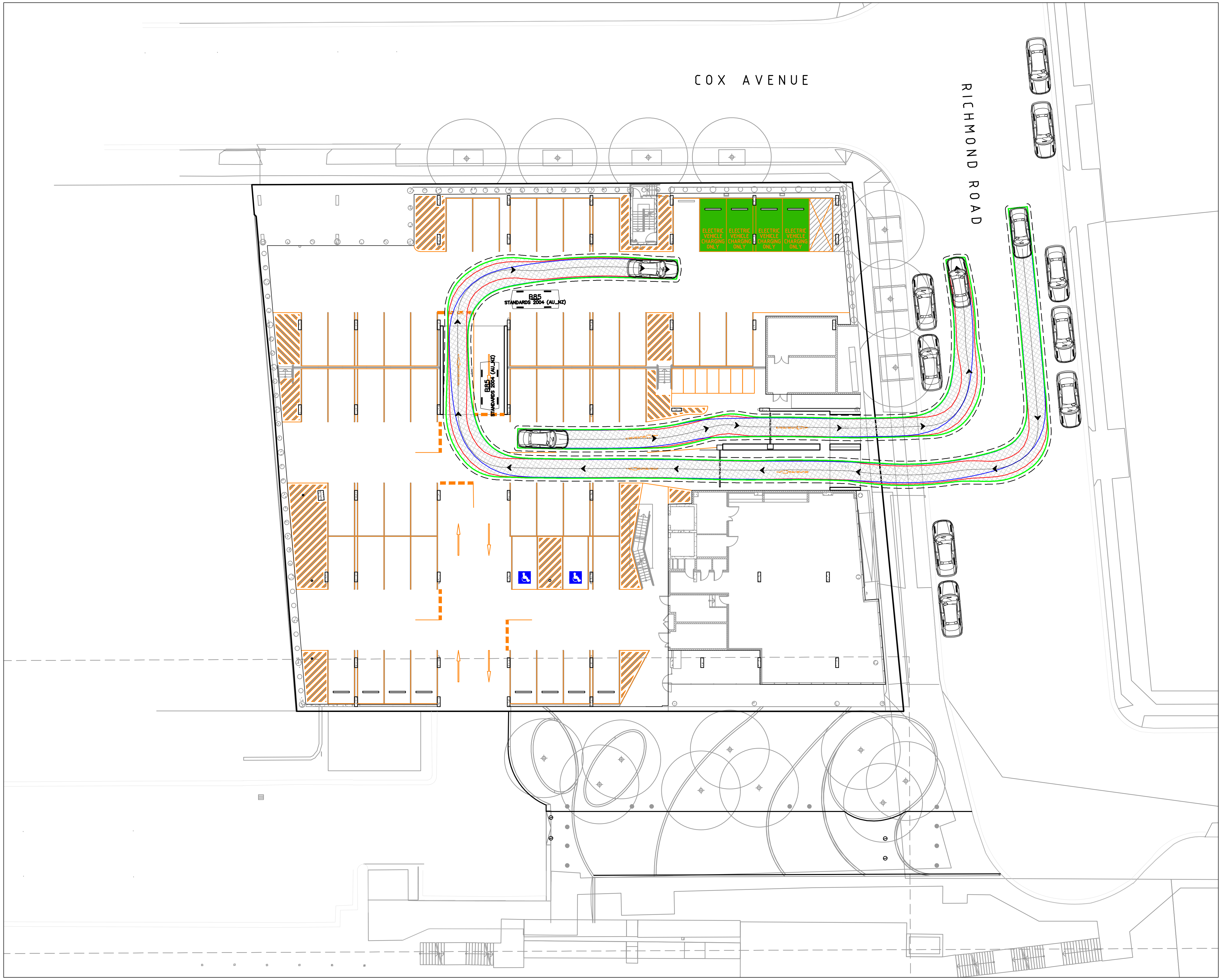
CIVIL WORKS VEHICLE TURNING MOVEMENTS LOWER GROUND LEVEL B99 SHEET 1 OF 2

JOB NUMBER **210295**

DRAWING NUMBER **C041**

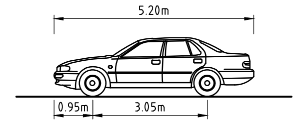
REVISION **2**

DRAWING SHEET SIZE = A1



LEGEND

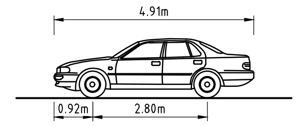
(red line)	DENOTES FRONT WHEEL PATH
(blue line)	DENOTES REAR WHEEL PATH
(green hatched box)	DENOTES VEHICLE BODY OVER HANG
(dashed line)	DENOTES 300mm VEHICLE BODY OFFSET



AS2890.1 – B99 CAR

NOT TO SCALE

WIDTH	1.94m
TRACK	1.84m
LOCK TO LOCK TIME	6.0s
STEERING ANGLE	33.9°



AS2890.1 – B85 CAR

NOT TO SCALE

WIDTH	1.87m
TRACK	1.77m
LOCK TO LOCK TIME	6.0s
STEERING ANGLE	34.1°

NOT FOR CONSTRUCTION

DRAWN B.CASTLE
DESIGNED N.GRINTER
JOB MANAGER
VERIFIER

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
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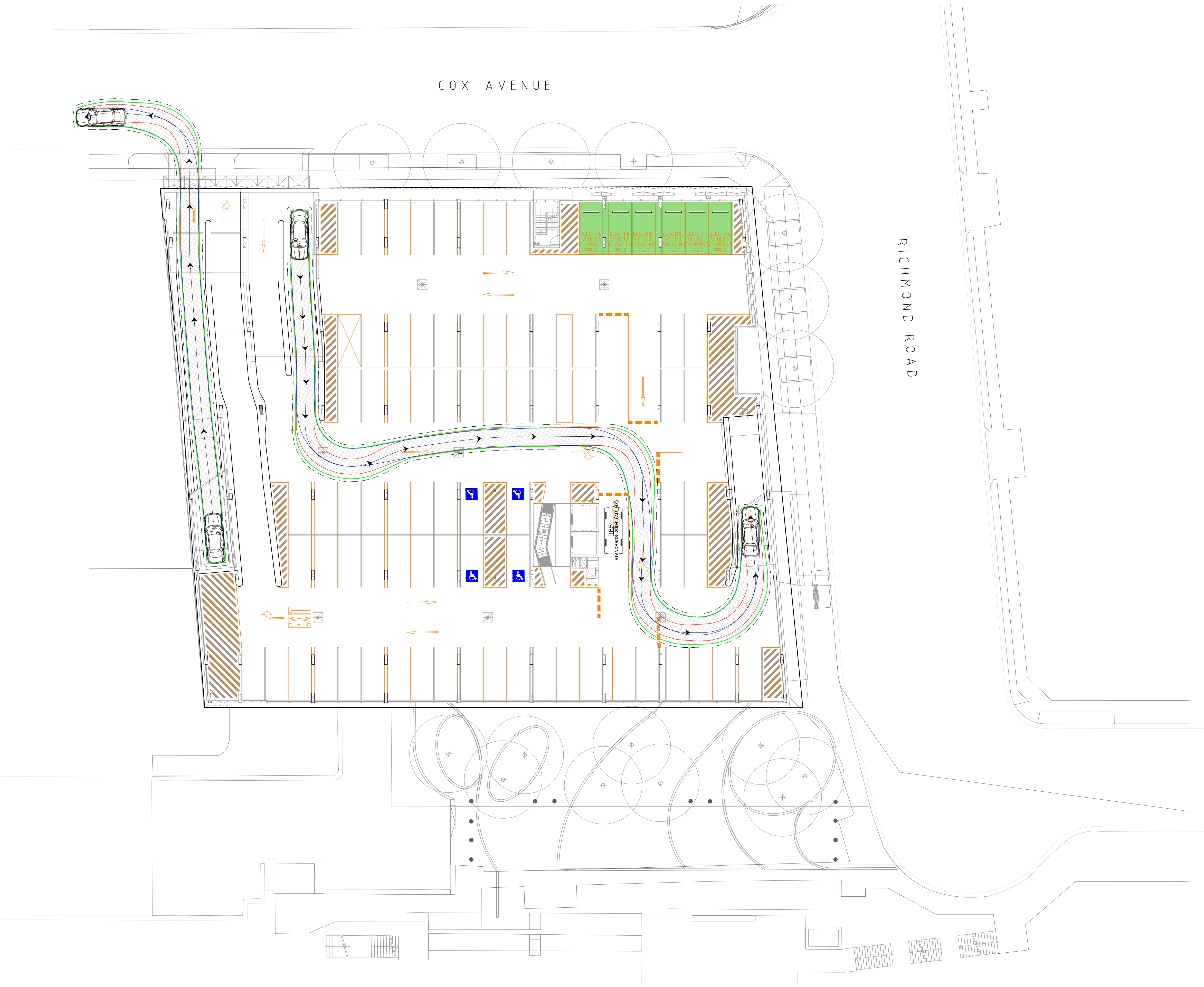
Email canberra@northrop.com.au ABN 81 094 433 100

PROJECT
KINGSWOOD COMMUTER CARPARK
RICHMOND ROAD AND COX AVENUE

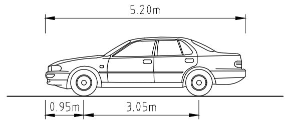
DRAWING TITLE
CIVIL WORKS
VEHICLE TURNING MOVEMENTS
LOWER GROUND LEVEL
B99 SHEET 2 OF 2

JOB NUMBER 210295
DRAWING NUMBER C042
REVISION 2
DRAWING SHEET SIZE = A1



LEGEND

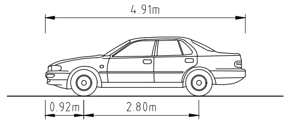
DENOTES FRONT WHEEL PATH
DENOTES REAR WHEEL PATH
DENOTES VEHICLE BODY OVER HANG
DENOTES 300mm VEHICLE BODY OFFSET



AS2890.1 – B99 CAR

NOT TO SCALE

WIDTH	1.94m
TRACK	1.84m
LOCK TO LOCK TIME	6.0s
STEERING ANGLE	33.9°



AS2890.1 – B85 CAR

NOT TO SCALE

WIDTH	1.87m
TRACK	1.77m
LOCK TO LOCK TIME	6.0s
STEERING ANGLE	34.1°

NOT FOR CONSTRUCTION

DRAWN: B.CASTLE
DESIGNED: N.GRINTER
JOB MANAGER: M.PIKE
VERIFIER:

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	PRELIMINARY	BC		NG	27.06.22
2	PRELIMINARY	BC		NG	29.06.22

CLIENT

PENRITH CITY COUNCIL

DRAWING NOT TO BE USED FOR CONSTRUCTION UNLESS VERIFICATION SIGNATURE HAS BEEN ADDED

ARCHITECT

sam crawford architects

ALL SETOUT TO ARCHITECT'S DRAWINGS, DIMENSIONS TO BE VERIFIED WITH THE ARCHITECT AND ON SITE BEFORE MAKING SHOP DRAWINGS OR COMMENCING WORK.
NORTHROP ACCEPTS NO RESPONSIBILITY FOR THE USABILITY, COMPLETENESS OR SCALE OF DRAWINGS TRANSFERRED ELECTRONICALLY.

0 2 4 6 8 10m
PLAN
SCALE 1:200 @ A1

NORTHROP
Canberra
Level 6, 224 Bunda Street (PO Box 213) Canberra ACT 2608
Ph (02) 6285 1822 Fax (02) 6285 1863
Email canberra@northrop.com.au ABN 81 094 433 100

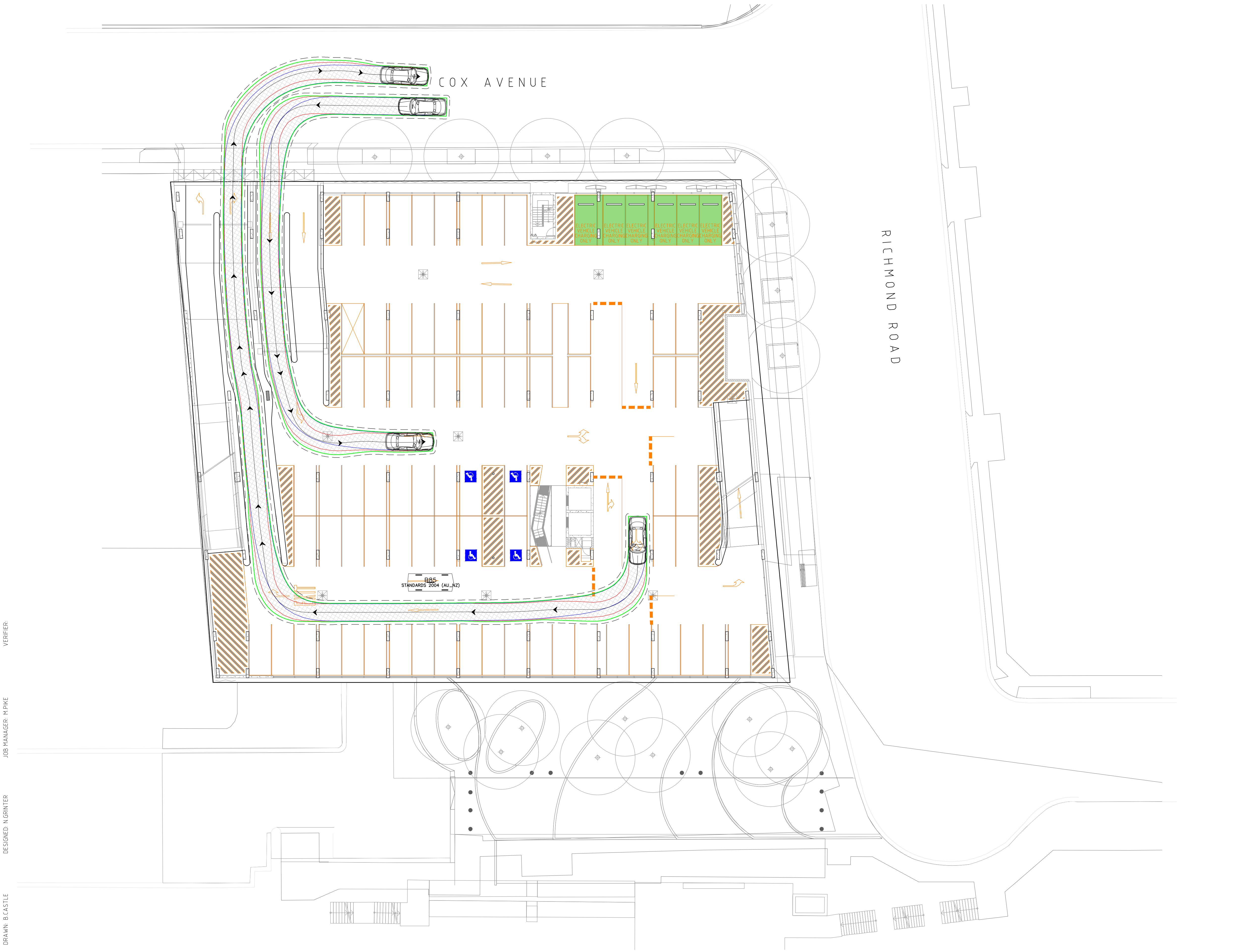
PROJECT

KINGSWOOD COMMUTER CARPARK
RICHMOND ROAD AND COX AVENUE

DRAWING TITLE

CIVIL WORKS
VEHICLE TURNING MOVEMENTS
GROUND FLOOR
B99 SHEET 1 OF 2

JOB NUMBER 210295
DRAWING NUMBER C045
REVISION 2
DRAWING SHEET SIZE = A1



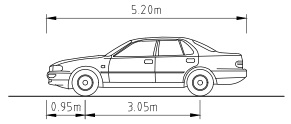
LEGEND

DENOTES FRONT WHEEL PATH

DENOTES REAR WHEEL PATH

DENOTES VEHICLE BODY OVER HANG

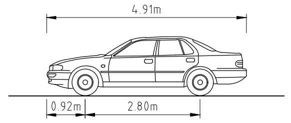
DENOTES 300mm VEHICLE BODY OFFSET



AS2890.1 - B99 CAR

NOT TO SCALE

WIDTH	1.94m
TRACK	1.84m
LOCK TO LOCK TIME	6.0s
STEERING ANGLE	33.9°



AS2890.1 - B85 CAR

NOT TO SCALE

WIDTH	1.87m
TRACK	1.77m
LOCK TO LOCK TIME	6.0s
STEERING ANGLE	34.1°

VERIFIER:

JOB MANAGER: M.PIKE

DESIGNED: N.GRINTER

DRAWN: B.CASTLE

NOT FOR CONSTRUCTION

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	PRELIMINARY	BC		NG	27.06.22
2	PRELIMINARY	BC		NG	29.06.22

CLIENT

PENRITH CITY COUNCIL

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ARCHITECT

sam crawford architects

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0 2 4 6 8 10m

PLAN

SCALE 1:200 @ A1

NORTHROP
Canberra
Level 6, 224 Bunda Street (PO Box 213) Canberra ACT 2608
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Email canberra@northrop.com.au ABN 81 094 433 100

PROJECT

KINGSWOOD COMMUTER CARPARK RICHMOND ROAD AND COX AVENUE

DRAWING TITLE

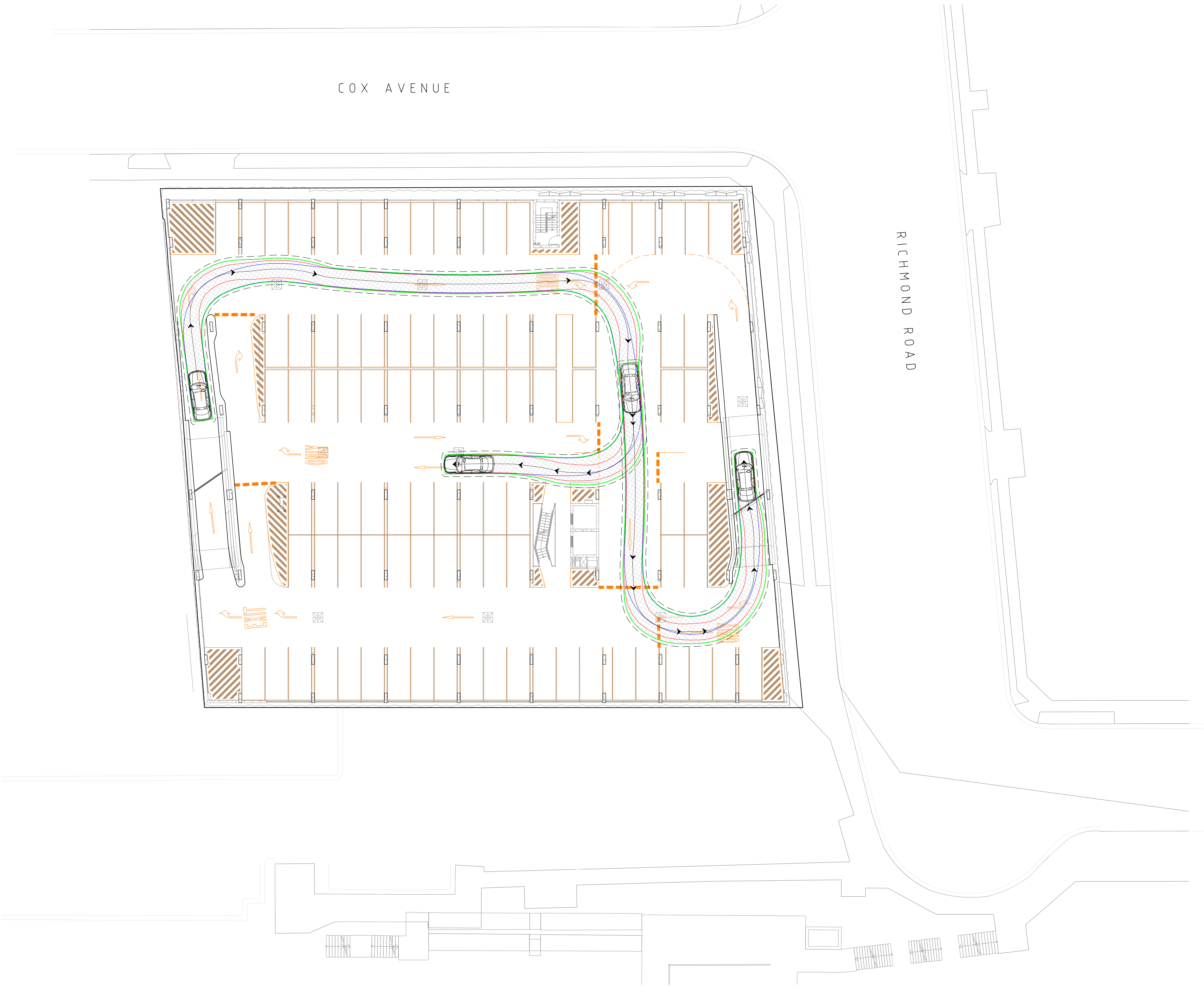
CIVIL WORKS
VEHICLE TURNING MOVEMENTS
GROUND FLOOR
B99 SHEET 2 OF 2

JOB NUMBER 210295

DRAWING NUMBER C046

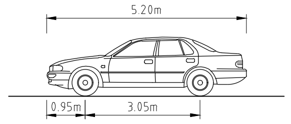
REVISION 2

DRAWING SHEET SIZE = A1



LEGEND

(red line)	DENOTES FRONT WHEEL PATH
(blue line)	DENOTES REAR WHEEL PATH
(hatched box)	DENOTES VEHICLE BODY OVER HANG
(dashed line)	DENOTES 300mm VEHICLE BODY OFFSET



AS2890.1 - B99 CAR

NOT TO SCALE

WIDTH	1.94m
TRACK	1.84m
LOCK TO LOCK TIME	6.0s
STEERING ANGLE	33.9°

VERIFIER:
JOB MANAGER: M.PIKE
DESIGNED: N.GRINTER
DRAWN: B.CASTLE

NOT FOR CONSTRUCTION

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	PRELIMINARY	BC		NG	27.06.22
2	PRELIMINARY	BC		NG	05.07.22

CLIENT: PENRITH CITY COUNCIL

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ARCHITECT: sam crawford architects

ALL SETOUT TO ARCHITECT'S DRAWINGS, DIMENSIONS TO BE VERIFIED WITH THE ARCHITECT AND ON SITE BEFORE MAKING SHOP DRAWINGS OR COMMENCING WORK.
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0 2 4 6 8 10m

PLAN
SCALE 1:200 @ A1

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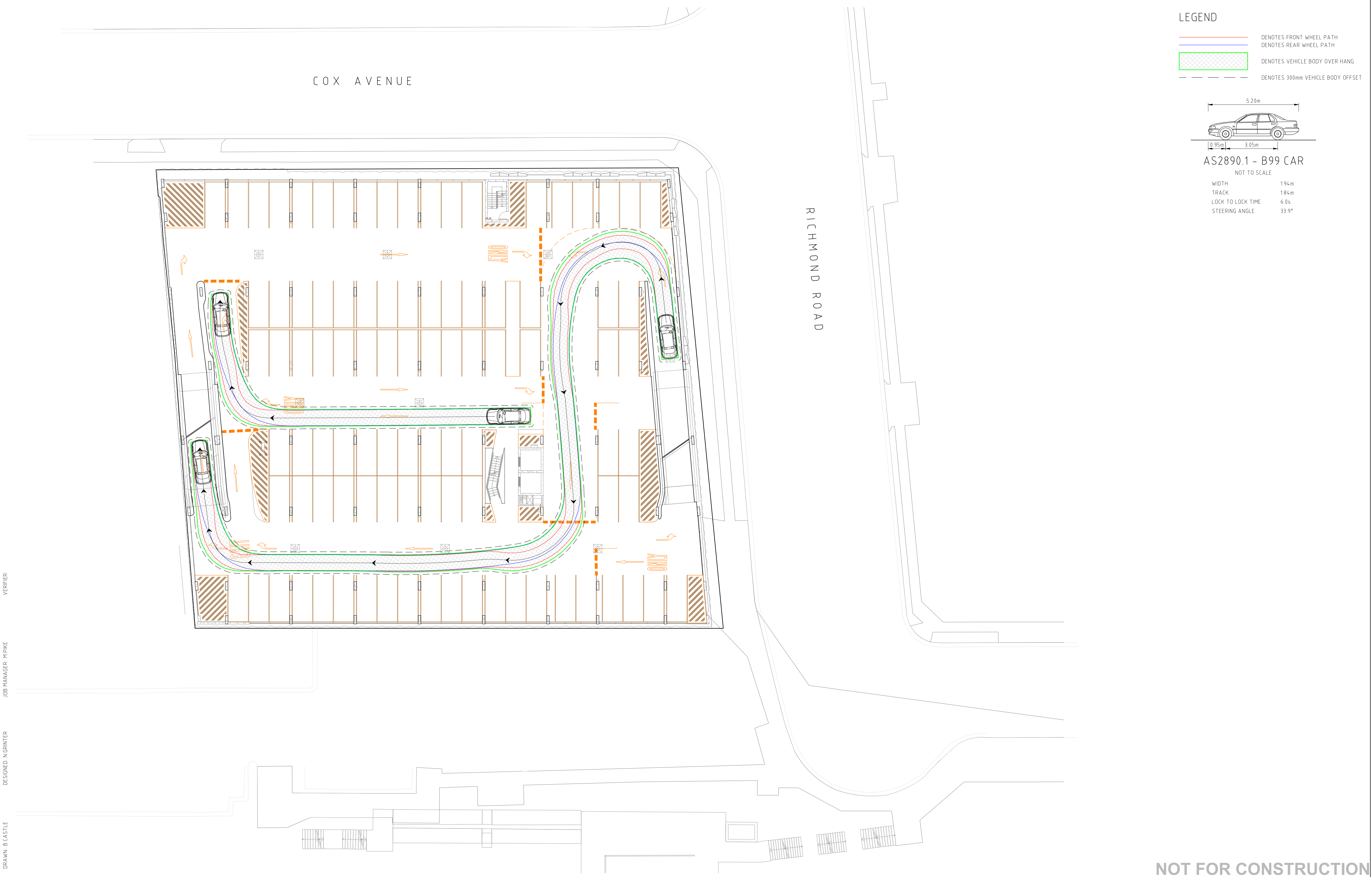
PROJECT
KINGSWOOD COMMUTER CARPARK RICHMOND ROAD AND COX AVENUE

DRAWING TITLE
CIVIL WORKS VEHICLE TURNING MOVEMENTS LEVEL 1 AND 2 B99 SHEET 1 OF 3

JOB NUMBER: 210295
DRAWING NUMBER: C050
REVISION: 2
DRAWING SHEET SIZE = A1



NOT FOR CONSTRUCTION

VERIFIER:

JOB MANAGER: M.PIKE

DESIGNED: N.GRINTER

DRAWN: B.CASTLE

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	PRELIMINARY	BC		NG	27.06.22
2	PRELIMINARY	RC		NG	28.06.22
3	PRELIMINARY	BC		NG	05.07.22

CLIENT

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ARCHITECT

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0 2 4 6 8 10m

PLAN

SCALE 1:200 @ A1

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PROJECT

KINGSWOOD COMMUTER CARPARK
RICHMOND ROAD AND COX AVENUE

DRAWING TITLE

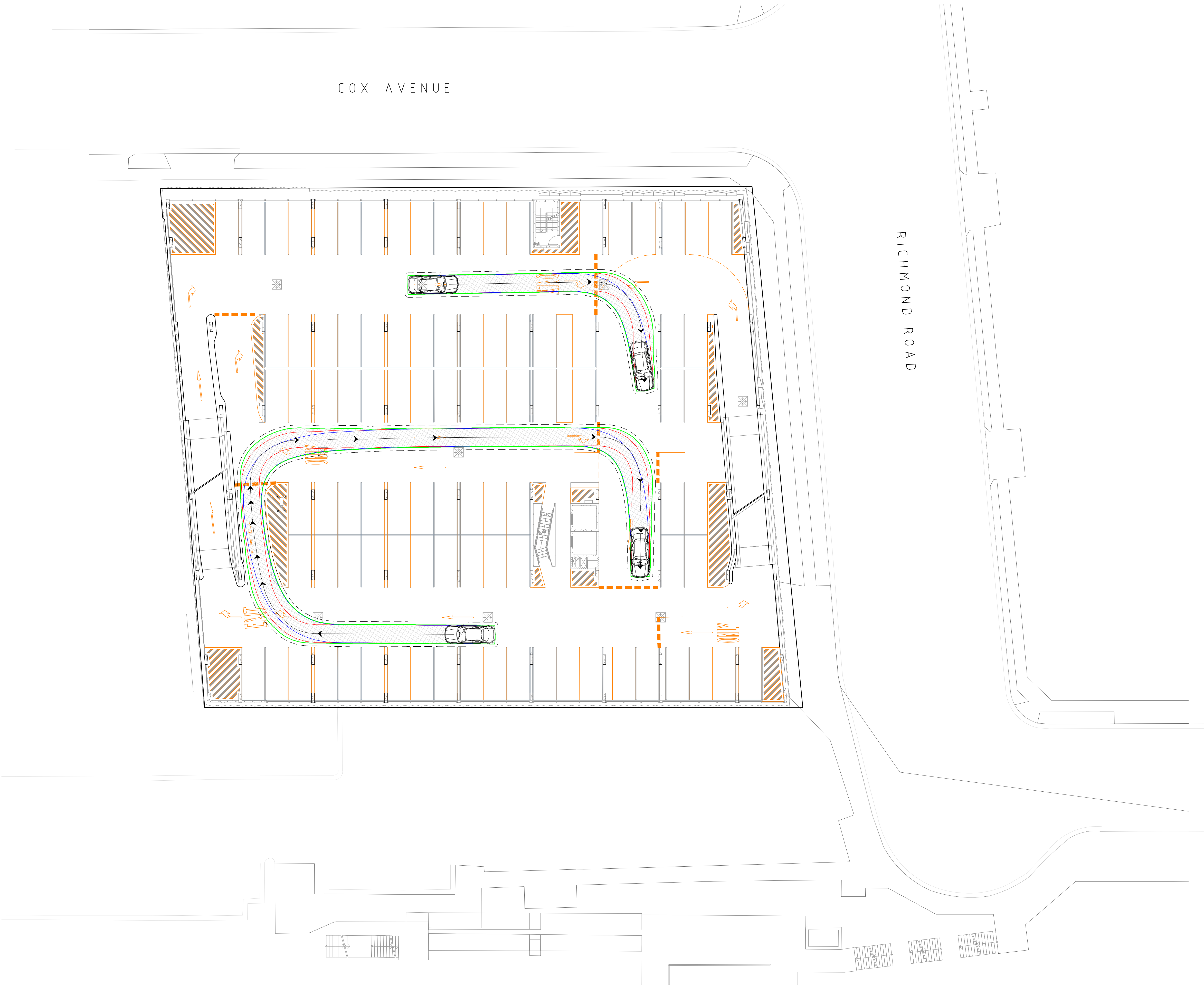
CIVIL WORKS
VEHICLE TURNING MOVEMENTS
LEVEL 1 AND 2
B99 SHEET 2 OF 3

JOB NUMBER 210295

DRAWING NUMBER C051

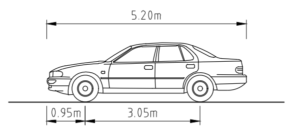
REVISION 3

DRAWING SHEET SIZE = A1



LEGEND

DENOTES FRONT WHEEL PATH
DENOTES REAR WHEEL PATH
DENOTES VEHICLE BODY OVER HANG
DENOTES 300mm VEHICLE BODY OFFSET



AS2890.1 - B99 CAR

NOT TO SCALE

WIDTH	1.94m
TRACK	1.84m
LOCK TO LOCK TIME	6.0s
STEERING ANGLE	33.9°

VERIFIER:
JOB MANAGER: M.PIKE
DESIGNED: N.GRINTER
DRAWN: B.CASTLE

NOT FOR CONSTRUCTION

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	PRELIMINARY	BC		NG	27.06.22
2	PRELIMINARY	RC		NG	28.06.22
3	PRELIMINARY	BC		NG	05.07.22

CLIENT

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0 2 4 6 8 10m

PLAN
SCALE 1:200 @ A1

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PROJECT

KINGSWOOD COMMUTER CARPARK RICHMOND ROAD AND COX AVENUE

DRAWING TITLE

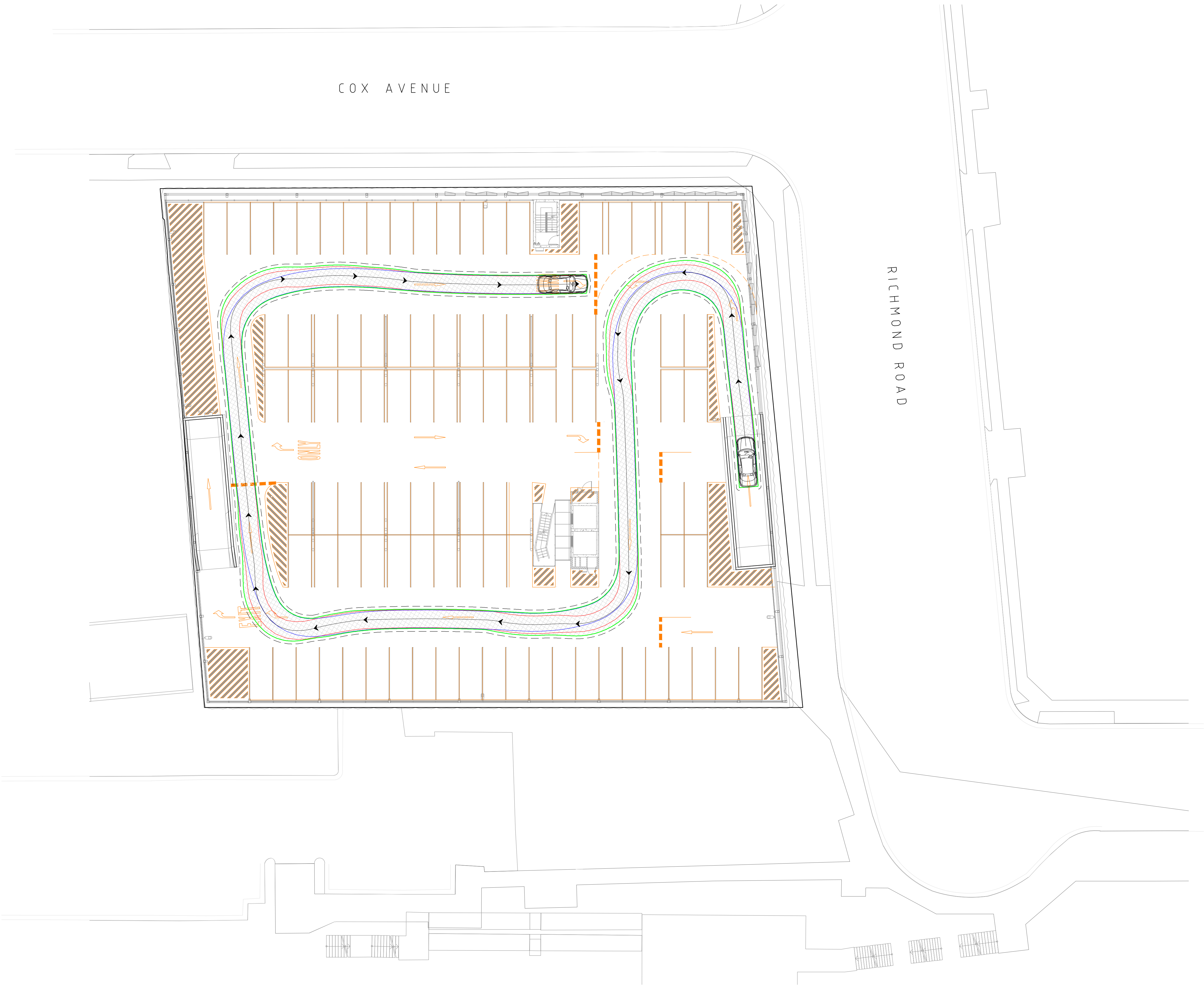
CIVIL WORKS VEHICLE TURNING MOVEMENTS LEVEL 1 AND 2 B99

JOB NUMBER
210295

DRAWING NUMBER
C052

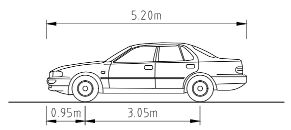
REVISION
3

DRAWING SHEET SIZE = A1



LEGEND

DENOTES FRONT WHEEL PATH
DENOTES REAR WHEEL PATH
DENOTES VEHICLE BODY OVER HANG
DENOTES 300mm VEHICLE BODY OFFSET



AS2890.1 - B99 CAR

NOT TO SCALE

WIDTH	1.94m
TRACK	1.84m
LOCK TO LOCK TIME	6.0s
STEERING ANGLE	33.9°

DRAWN: B.CASTLE
DESIGNED: N.GRINTER
JOB MANAGER: M.PIKE
VERIFIER:

NOT FOR CONSTRUCTION

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	PRELIMINARY	BC		NG	27.06.22
2	PRELIMINARY	BC		NG	05.07.22

CLIENT
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0 2 4 6 8 10m

PLAN
SCALE 1:200 @ A1

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Email canberra@northrop.com.au ABN 81 094 433 100

PROJECT
KINGSWOOD COMMUTER CARPARK
RICHMOND ROAD AND COX AVENUE

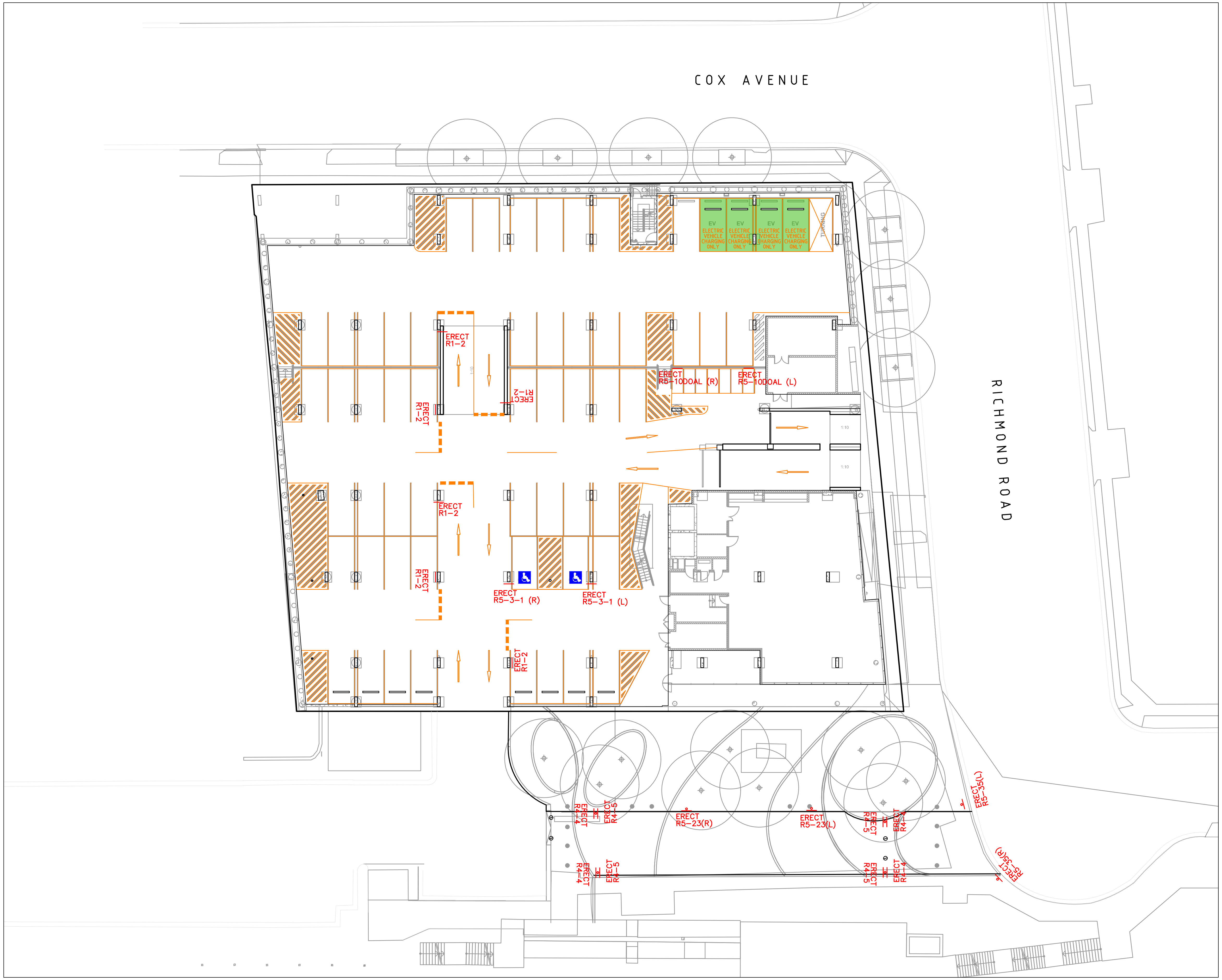
DRAWING TITLE
CIVIL WORKS
VEHICLE TURNING MOVEMENTS
LEVEL 3
B99

JOB NUMBER
210295

DRAWING NUMBER
C055

REVISION
2

DRAWING SHEET SIZE = A1



LEGEND

APPLY NEW LINEMARKING

R5-23/3(R) ERECT NEW SIGN

NEW WHEEL STOPS

SIGNAGE AND LINEMARKING

1. ALL SIGNAGE TO BE INSTALLED IN ACCORDANCE WITH AUSTRALIAN STANDARDS 1742 / TfNSW STANDARDS AND SPECIFICATIONS.
2. LINE MARKING AND PAINT SHALL BE IN ACCORDANCE WITH AS1742.3 AND TfNSW STANDARDS.
3. PAINT SHALL BE TYPE 3 CLASS 'A' AND THE COLOUR SHALL BE WHITE AND NOT SUBJECT TO DISCOLOURATION BY BITUMEN FROM ROAD SURFACE. ALL PAINT TO BE APPLIED BY MECHANICAL SPRAYER. LINE MARKING SHALL BE APPLIED AT A WET THICKNESS OF BETWEEN 0.35mm AND 0.40mm
4. PAINT SHALL BE APPLIED AT A WET THICKNESS OF BETWEEN 0.35mm AND 0.40mm.
5. CARPARK LINEMARKING TO BE 80mm WIDE.
6. REFER TO AUSTROADS FOR REMOVAL OF LINEMARKING.
7. CONTACT SUPERINTENDENT IF THERE ARE ANY DISCREPANCIES BETWEEN THESE NOTES AND AUSTRALIAN STANDARDS / TfNSW STANDARDS AND SPECIFICATIONS.

SIGN	DESCRIPTION	HAND	SIZE	NO. OF
R5-3-1 (R)	DISABLED PARKING	R	A	1
R5-3-1 (L)	DISABLED PARKING	L	A	1
R1-2	GIVEWAY	-	A	6
R5-35 (R)	NO STOPPING	R	A	1
R5-35 (L)	NO STOPPING	L	A	1
R5-10-1 (R)	MOTORCYCLE PARKING	R	A	1
R5-10-1 (L)	MOTORCYCLE PARKING	L	A	1
R4-4	10KM/H SHARED ZONE	-	A	4
R4-5	END OF SHARED ZONE	-	A	4
R5-23 (R)	LOADING ZONE	R	A	1
R5-23 (L)	LOADING ZONE	L	A	1

SIGNS TO BE ERECTED

DRAWN: R.CRADDY
DESIGNED: N.GRINTER
JOB MANAGER: S.PARAJULI
VERIFIER:

NOT FOR CONSTRUCTION

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	PRELIMINARY	BC		NG	27.06.22
2	PRELIMINARY	BC		NG	27.06.22
3	PRELIMINARY	BC		NG	06.07.22

CLIENT
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ARCHITECT
sam crawford architects

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0 2 4 6 8 10m
PLAN
SCALE 1:200 @ A1

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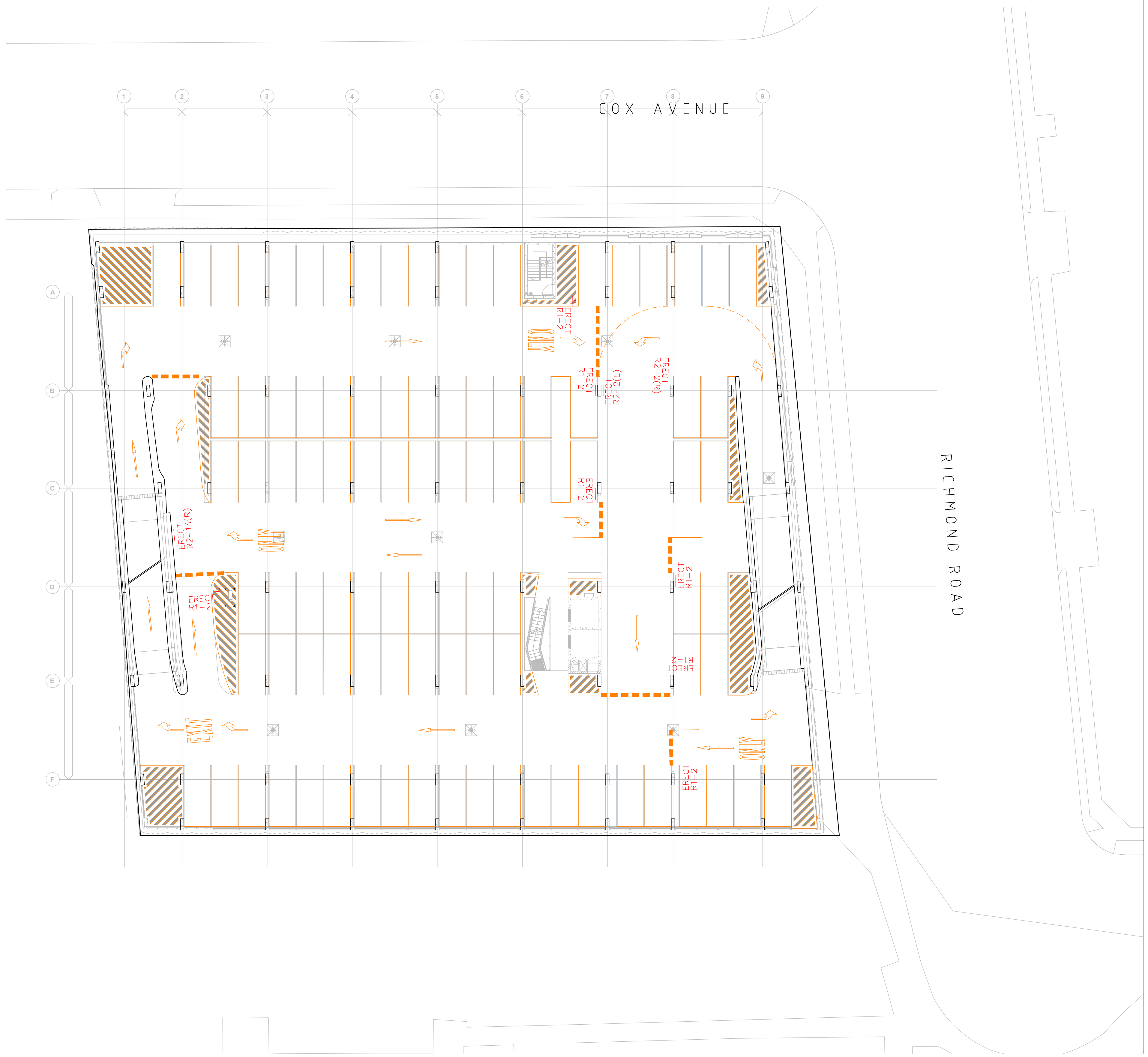
Level 6, 224 Bunda Street (PO Box 213) Canberra ACT 2608
Ph (02) 6285 1822 Fax (02) 6285 1863
Email canberra@northrop.com.au ABN 81 094 433 100

PROJECT
KINGSWOOD COMMUTER CARPARK RICHMOND ROAD AND COX AVENUE

DRAWING TITLE
CIVIL WORKS
TRAFFIC CONTROL DEVICES PLAN
LOWER GROUND FLOOR

JOB NUMBER 210295
DRAWING NUMBER C190
REVISION 3
DRAWING SHEET SIZE = A1



LEGEND

APPLY NEW LINEMARKING

R5-23/3(R) ERECT NEW SIGN

NEW WHEEL STOPS

SIGNAGE AND LINEMARKING

1. ALL SIGNAGE TO BE INSTALLED IN ACCORDANCE WITH AUSTRALIAN STANDARDS 1742 / TfNSW STANDARDS AND SPECIFICATIONS.
2. LINE MARKING AND PAINT SHALL BE IN ACCORDANCE WITH AS1742.3 AND TfNSW STANDARDS.
3. PAINT SHALL BE TYPE 3 CLASS 'A' AND THE COLOUR SHALL BE WHITE AND NOT SUBJECT TO DISCOLOURATION BY BITUMEN FROM ROAD SURFACE. ALL PAINT TO BE APPLIED BY MECHANICAL SPRAYER. LINE MARKING SHALL BE APPLIED AT A WET THICKNESS OF BETWEEN 0.35mm AND 0.40mm
4. PAINT SHALL BE APPLIED AT A WET THICKNESS OF BETWEEN 0.35mm AND 0.40mm.
5. CARPARK LINEMARKING TO BE 80mm WIDE.
6. REFER TO AUSTROADS FOR REMOVAL OF LINEMARKING.
7. CONTACT SUPERINTENDENT IF THERE ARE ANY DISCREPANCIES BETWEEN THESE NOTES AND AUSTRALIAN STANDARDS / TfNSW STANDARDS AND SPECIFICATIONS.

R1-2	GIVEWAY	-	A	7
R2-2 (L)	ONE WAY	L	A	1
R2-2 (R)	ONE WAY	R	A	1
R2-14 (R)	RIGHT ONLY	R	A	1
SIGN	DESCRIPTION	HAND	SIZE	NO. OF

SIGNS TO BE ERECTED ON EACH FLOOR

NOT FOR CONSTRUCTION

DRAWN: R.CRADDY
DESIGNED: N.GRINTER
JOB MANAGER: S.PARAJULI
VERIFIER:

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	PRELIMINARY	BC		NG	27.06.22
2	PRELIMINARY	BC		NG	05.07.22

CLIENT: PENRITH CITY COUNCIL

DRAWING NOT TO BE USED FOR CONSTRUCTION UNLESS VERIFICATION SIGNATURE HAS BEEN ADDED

ARCHITECT: sam crawford architects

ALL SETOUT TO ARCHITECT'S DRAWINGS, DIMENSIONS TO BE VERIFIED WITH THE ARCHITECT AND ON SITE BEFORE MAKING SHOP DRAWINGS OR COMMENCING WORK.
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0 2 4 6 8 10m
PLAN
SCALE 1:200 @ A1

NORTHROP
Canberra
Level 6, 224 Bunda Street (PO Box 213) Canberra ACT 2608
Ph (02) 6285 1822 Fax (02) 6285 1863
Email canberra@northrop.com.au ABN 81 094 433 100

PROJECT: KINGSWOOD COMMUTER CARPARK RICHMOND ROAD AND COX AVENUE

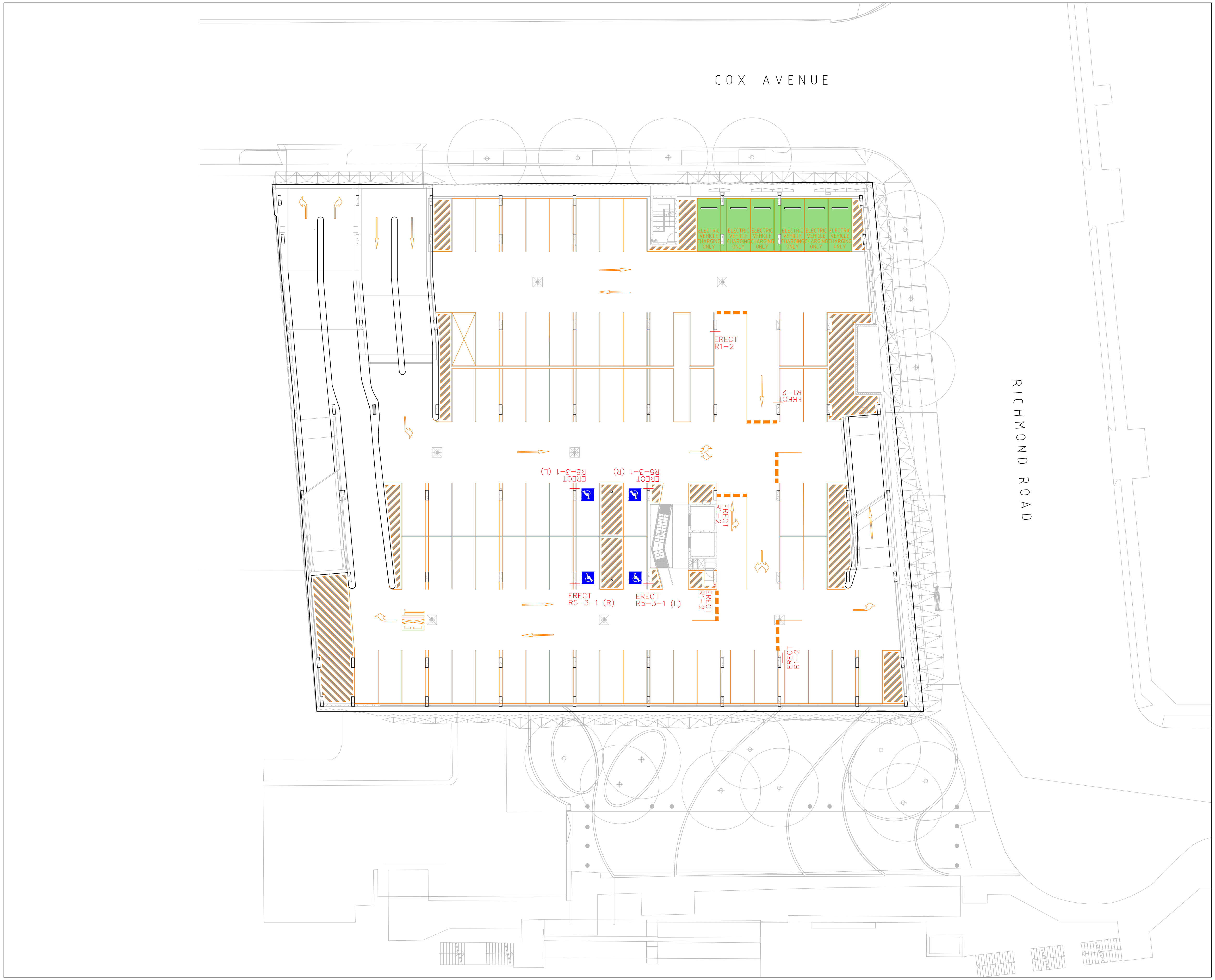
DRAWING TITLE: CIVIL WORKS TRAFFIC CONTROL DEVICES PLAN LEVEL 1 AND 2

JOB NUMBER: 210295

DRAWING NUMBER: C192

REVISION: 2

DRAWING SHEET SIZE = A1



LEGEND

	APPLY NEW LINEMARKING
R5-23/3(R)	ERECT NEW SIGN
	NEW WHEEL STOPS

SIGNAGE AND LINEMARKING

1. ALL SIGNAGE TO BE INSTALLED IN ACCORDANCE WITH AUSTRALIAN STANDARDS 1742 / TfNSW STANDARDS AND SPECIFICATIONS.
2. LINE MARKING AND PAINT SHALL BE IN ACCORDANCE WITH AS1742.3 AND TfNSW STANDARDS.
3. PAINT SHALL BE TYPE 3 CLASS 'A' AND THE COLOUR SHALL BE WHITE AND NOT SUBJECT TO DISCOLOURATION BY BITUMEN FROM ROAD SURFACE. ALL PAINT TO BE APPLIED BY MECHANICAL SPRAYER. LINE MARKING SHALL BE APPLIED AT A WET THICKNESS OF BETWEEN 0.35mm AND 0.40mm
4. PAINT SHALL BE APPLIED AT A WET THICKNESS OF BETWEEN 0.35mm AND 0.40mm.
5. CARPARK LINEMARKING TO BE 80mm WIDE.
6. REFER TO AUSTROADS FOR REMOVAL OF LINEMARKING.
7. CONTACT SUPERINTENDENT IF THERE ARE ANY DISCREPANCIES BETWEEN THESE NOTES AND AUSTRALIAN STANDARDS / TfNSW STANDARDS AND SPECIFICATIONS.

SIGN	DESCRIPTION	HAND	SIZE	NO. OF
R1-2	GIVEWAY	-	A	5
R5-3-1 (R)	DISABLED PARKING	R	A	2
R5-3-1 (L)	DISABLED PARKING	L	A	2

SIGNS TO BE ERECTED

NOT FOR CONSTRUCTION

DRAWN: R.CRADDY
DESIGNED: N.GRINTER
JOB MANAGER: S.PARAJULI
VERIFIER:

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	PRELIMINARY	BC		NG	27.06.22
2	PRELIMINARY	BC		NG	29.06.22
3	PRELIMINARY	BC		NG	05.07.22

CLIENT
PENRITH CITY COUNCIL
DRAWING NOT TO BE USED FOR CONSTRUCTION UNLESS VERIFICATION SIGNATURE HAS BEEN ADDED

ARCHITECT
sam crawford architects

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0 2 4 6 8 10m
PLAN
SCALE 1:200 @ A1

NORTHROP
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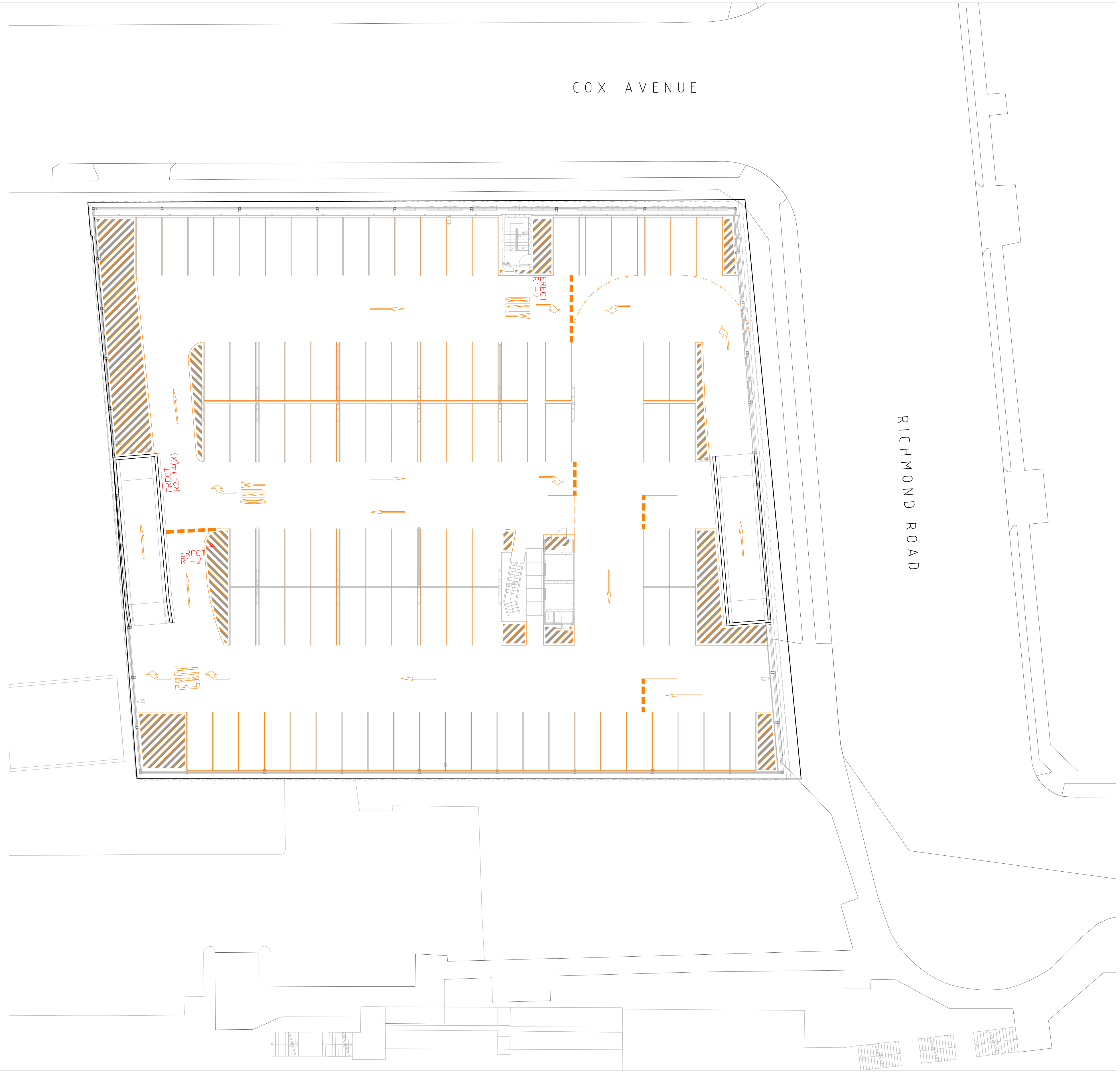
Ph (02) 6285 1822 Fax (02) 6285 1863
Email canberra@northrop.com.au ABN 81 094 433 100

PROJECT
KINGSWOOD COMMUTER CARPARK
RICHMOND ROAD AND COX AVENUE

DRAWING TITLE
CIVIL WORKS
TRAFFIC CONTROL DEVICES PLAN
GROUND FLOOR

JOB NUMBER 210295
DRAWING NUMBER C191
REVISION 3
DRAWING SHEET SIZE = A1



LEGEND

APPLY NEW LINEMARKING
R5-23/3(R) ERECT NEW SIGN
NEW WHEEL STOPS

SIGNAGE AND LINEMARKING

1. ALL SIGNAGE TO BE INSTALLED IN ACCORDANCE WITH AUSTRALIAN STANDARDS 1742 / TfNSW STANDARDS AND SPECIFICATIONS.
2. LINE MARKING AND PAINT SHALL BE IN ACCORDANCE WITH AS1742.3 AND TfNSW STANDARDS.
3. PAINT SHALL BE TYPE 3 CLASS 'A' AND THE COLOUR SHALL BE WHITE AND NOT SUBJECT TO DISCOLOURATION BY BITUMEN FROM ROAD SURFACE. ALL PAINT TO BE APPLIED BY MECHANICAL SPRAYER. LINE MARKING SHALL BE APPLIED AT A WET THICKNESS OF BETWEEN 0.35mm AND 0.40mm
4. PAINT SHALL BE APPLIED AT A WET THICKNESS OF BETWEEN 0.35mm AND 0.40mm.
5. CARPARK LINEMARKING TO BE 80mm WIDE.
6. REFER TO AUSTROADS FOR REMOVAL OF LINEMARKING.
7. CONTACT SUPERINTENDENT IF THERE ARE ANY DISCREPANCIES BETWEEN THESE NOTES AND AUSTRALIAN STANDARDS / TfNSW STANDARDS AND SPECIFICATIONS.

R1-2	GIVEWAY	-	A	2
R2-14 (R)	RIGHT ONLY	R	A	1
SIGN	DESCRIPTION	HAND	SIZE	NO. OF

SIGNS TO BE ERECTED

NOT FOR CONSTRUCTION

DRAWN: R.CRADDY
DESIGNED: N.GRINTER
JOB MANAGER: S.PARAJULI
VERIFIER:

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	PRELIMINARY	BC		NG	27.06.22
2	PRELIMINARY	BC		NG	05.07.22

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PROJECT: KINGSWOOD COMMUTER CARPARK RICHMOND ROAD AND COX AVENUE

DRAWING TITLE: CIVIL WORKS TRAFFIC CONTROL DEVICES PLAN LEVEL 3

JOB NUMBER: 210295
DRAWING NUMBER: C193
REVISION: 2
DRAWING SHEET SIZE = A1

Appendix E

Landscape character and visual impact assessment iris

Kingswood Commuter Carpark Upgrade

Landscape and Visual Impact Assessment

IRIS Visual Planning + Design

Kingswood commuter car park project – Landscape and Visual Impact Assessment

Job No: 2021-208

12/7/2022

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Table 1-1 Abbreviations

Term	Meaning
CCTV	Closed Circuit TV
CPTED	Crime Prevention Through Environmental Design
DDA	*Disability Discrimination Act 1992*

Table 1-2 Definitions

Term	Meaning
Concept design	The concept design is based on the drawings presented in concept design document (dated 19/04/2022), which would be refined by the Contractor (should the Proposal proceed) to a design suitable for construction (subject to Council acceptance).
Detailed design	Detailed design broadly refers to the process that the Contractor undertakes (should the Proposal proceed) to refine the concept design to a design suitable for construction (subject to Council acceptance).
Out of hours work	Defined as works *outside* standard construction hours (i.e. outside of 7am to 6pm Monday to Friday, 8am to 1pm Saturday and no work on Sundays/public holidays).
The Proposal	The construction and operation of Kingswood commuter car park.

1. Introduction

1.1.Study scope

Penrith City Council is proposing a commuter car park at Kingswood (the Proposal). This assessment identifies the potential visual impacts of the Proposal on views to the car park from surrounding areas.

The study area for this Proposal extends generally north to the Penrith General Cemetery, east to the schools and residences along Richmond Road, south across Kingswood station and to the commercial properties along the Great Western Highway, and west to the industrial areas north of the rail corridor along Cox Avenue.

This assessment considers the impact on views from surrounding residential, industrial and commercial areas, footpaths and streets, and Kingswood Railway Station. The potential views from neighbouring properties will be inferred from these public views and site observations.

The assessment has identified the impacts of the Proposal during the day and night, construction and operation.

This assessment also considers the urban design and landscape impacts of the Proposal. This includes a review of relevant Council objectives, identification of any direct landscape impacts such as tree removal, and a general assessment of the potential overshadowing impacts of the project.

1.2.Site location and description

The Proposal is located in the suburb of Kingswood about two kilometres east of Penrith town centre.

The site is located immediately north of Kingswood railway station, at the corner of Cox Avenue and Richmond Road. Kingswood Station is on the T1 Main Western line and has recently been upgraded as part of the Transport for NSW Transport Accessibility Program.

The site is currently used as an at grade commuter car park, servicing commuters. The site is surrounded by a mixture of land uses, including industrial, residential, and community (cemetery).

The site location is shown in Figure 1-1 and the existing site conditions are described in more detail in section 5.1.

FIGURE 1-1 SITE LOCATION AND CONTEXT

2. The Proposal

2.1. Proposal components

The Proposal includes the construction of a five-level multi-storey commuter car park with:

- about 418 new car parking spaces, including accessible parking spaces, motor bike parking spaces, bicycle storage and electric vehicle charging stations
- an open roof with freestanding solar panels
- three vehicle access and egress points, on Cox Avenue, Richmond Road and through the Transport for NSW at-grade car park
- a new shared access to the Transport of NSW at-grade car park via Richmond Road
- ancillary works including services diversion and/or relocation, drainage works, landscaping, installation of lighting, installation of handrails and balustrades and new infrastructure (including wayfinding signage and CCTV cameras).

All trees and vegetation within the construction footprint for the car park structure would be removed, including up to about 27 mature trees within the southern area of the site and the shrubs along the western site boundary. A group of trees within the southern part of the site would however be retained, including up to about nine trees.

The public open space between the car park and train station would also be upgraded, including new paving, planting, seating, lighting and signage.

The car park would be illuminated to current lighting standards which may include motion sensor lights. This would include lighting within all areas of the car parking structure, entry driveway and pedestrian entries.

The car parking structure would be a concrete structure. An architectural screen system, comprising folded galvanised steel mech panels, would wrap around all sides of the structure. There would also be planter boxes integrated into the upper levels of the structure, including climbing plants.

A detailed description of the Proposal is provided in the Review of Environmental Factors. Artist's impressions of the Proposal are included at Figure 2-1 and 2-2.

2.2. Construction

A construction site would be established at the Proposal site. The eastern part of the existing commuter car park would also be used for materials storage, contractor site offices etc. for the duration of the works (refer to Figure 1-1).

The construction site would be enclosed with temporary security fencing and hoarding as required. The machinery and activities occurring on site would include excavators, cranes, heavy and light delivery vehicles, concrete trucks and pumps, and other typical construction equipment.

The construction methodology would be further developed during the detailed design stage, and would include the following construction activities:

- Site establishment and enabling works
- Demolition and site clearing works
- Earthworks including excavation and grading
- Building and structural works
- Installation of architectural features
- Landscaping and ancillary infrastructure
- Testing and commissioning
- Decommissioning of temporary facilities and site demobilisation.

Subject to approval, construction is expected to commence in quarter two of 2023 and take around 12 months to complete.

The existing car park would be closed for the duration of the works, however, the other nearby commuter car parks at Kingswood Station would remain open. The footpath along the south side of Cox Avenue and the western side of Richmond Road, adjacent to the site, would be temporarily closed.

A detailed description of the Proposal construction is provided in the REF.

FIGURE 2-1 DAYTIME ARTIST'S IMPRESSION OF THE PROPOSAL FROM THE SOUTHEAST, INCLUDING TREES (RETAINED AND PROPOSED)

FIGURE 2-2 NIGHT TIME ARTIST'S IMPRESSION OF THE PROPOSAL FROM THE NORTHEAST

3. Planning context

The following state and local government planning documents are relevant to the assessment of landscape and visual impact. These are summarised in the following paragraphs.

3.1. State planning documents

3.1.1. Greater Sydney Regional Plan: A Metropolis of Three Cities, NSW Greater Sydney Commission 2018

The Greater Sydney Regional Plan sets a 40-year vision (to 2056) and establishes a 20-year plan to manage growth and change for Greater Sydney in the context of social, economic and environmental matters (NSW Greater Sydney Commission, 2018a). It identifies three key cities in Greater Sydney, including the *'Western Parkland City*' which will be centred around the new Western Sydney International airport and Aerotropolis, as well as established centres such as Greater Penrith, which includes suburban areas such Kingswood (p.6-7).

Kingswood Station is located in the suburban area to the west of Penrith. The station and Proposal site is within the 'Greater Penrith to Eastern Creek Growth Area' (p.17), identified as a '*transformative corridor'* to deliver '*new land release areas, city-shaping transport investment and urban renewal, and infrastructure'* (p.43). Kingswood is identified as a local centre but is not part of a Transit Oriented Development site (p.17).

The plan recognises the '*dual function of streets as places for people and movement'* as being '*paramount'* to the design and management of '*great places*' (p.73). The Plan also prioritises amenity, including '*safe, direct and comfortable pathways for all people*' (p.74) with the '*protection of the amenity of public spaces from overshadowing is also important'* (p.101).

The region's '*green infrastructure*', including street tree plantings, are identified as valued assets for Greater Sydney (p.156). '*Expanding urban tree canopy in the public realm*' is a priority for Greater Sydney along streets, in parks and other public spaces, and on privately owned land, in Strategy 30.1 (p.164).

3.1.2. Western City District Plan, NSW Greater Sydney Commission

Greater Sydney's three cities, identified in the *Greater Sydney Regional Plan: A Metropolis of Three Cities* (NSW Greater Sydney Commission, 2018a), extend across five districts, including the Western District, which is a part of the Western Parkland City.

Kingswood, including the station and Proposal site, is located in the middle part of the Western District, and is identified as a local centre. '*Place-based planning'* (p.35) and '*creating and renewing great places and local centres'* are key priorities for local centres such as Kingswood (Planning Priority W6 p.48). Increasing urban tree canopy cover is also a key priority in the Plan (Planning Priority W15, p.119).

3.1.3. Better Placed, Office of the NSW State Government

The office of the NSW State Government Architect has prepared a suite of documents under the title of '*Better Placed*' which aims to improve the urban design quality of places in NSW. These documents include:

- Better Placed: An integrated design policy for the built environment of NSW, State Government Architect NSW (2018)
- Better Placed: Draft Good Urban Design Strategies for realising Better Placed objectives in the design of the built environment, State Government Architect NSW (2018)
- Better Methods: Evaluating Good Design, Implementing Better Placed design objectives into projects (2018).

These documents are intended to inform those involved in the design, planning, and development of the built environment in NSW. The overriding policy establishes the objectives and expectations in relation to design and creating good places.

The policy includes seven objectives for the design of the built environment, which are:

- Better fit – contextual, local and of its place
- Better performance – Sustainable, adaptable and durable
- Better for community – Inclusive, connected, and diverse

- Better for people – Safe, comfortable and liveable
- Better working – Functional, efficient and fit for purpose
- Better value – Creating and adding value
- Better look and feel – Engaging, inviting and attractive.

The principles identified in the *'Better Methods, Evaluating good design'* paper have generally informed the evaluation of the urban design impacts of the Proposal.

3.2. Local planning

Kingswood Station is located in the Penrith local government area (LGA). While the Proposal is not subject to local planning approval, the following planning documents contain the planning intent for areas surrounding the station and provide context to this assessment.

Relevant clauses from the *Penrith Local Strategic Planning Statement 2020*, *Penrith Local Environmental Plan 2010* and *Penrith Development Control Plan 2010* are summarised in the following sections.

3.2.1. Penrith Local Strategic Planning Statement, 2020

Penrith Local Strategic Planning Statement (LSPS) presents a local vision for land use within the Penrith LGA, that recognises the character of its suburbs. It is based around five themes, with several planning priorities for each theme. Relevant priorities include:

- *Planning Priority 7. Enrich our places*
- *Planning Priority 12. Enhance and grow Penrith's economic triangle*
- *Planning Priority 21: Cool our city.*

Planning Priority 7 aims to preserve and enhance the '*distinctive character'* of places, which includes all parts of the public realm such as open spaces, streets, centres and the interface with the private realm, such as residential, commercial and industrial streetscapes (p.45).

Kingswood, including the station and Proposal site, is identified as a 'key centre' within the Greater Penrith to Eastern Creek Growth Area and 'Penrith's Economic Triangle' (Planning Priority 12, p.67). Kingswood is one of three key centres identified '*to accommodate mixed-use and high density residential developments'* (p.34).

Planning Priority 21 aims to mitigate urban heat in Penrith, includes specific targeted building and design responses such as:

- *'using light-coloured surfaces to promote reflectivity of building roofs, paved surfaces and facades,*
- *protecting and increasing vegetation in the urban environment,*
- *increasing the use of WSUD principles to assist in the harvesting and reuse of water for cooling the urban environment and open space areas,*
- *increasing shade to hard surfaced areas, and*
- *using building design principles that are suited to our local climate'* (p.104).

3.2.2. Penrith Local Environmental Plan 2010

This statutory planning document is intended to guide planning decisions and manage the way land is used within the Penrith local government area. Through zoning and planning controls, the LEP is used to reserve land for open space, schools, transport or other public purpose as well as guide development and protect the environment.

Land use zoning

The Proposal site is zoned IN1 General Industrial. Although the objectives for this zone do not specifically include landscape and visual amenity provisions, it requires development to '*minimise any adverse effect of industry on other land uses'*.

Potential building heights

The Proposal site is identified for buildings up to a height of 12 metres. The objectives of this clause include:

(a) to ensure that buildings are compatible with the height, bulk and scale of the existing and desired future character of the locality,

(b) to minimise visual impact, disruption of views, loss of privacy and loss of solar access to existing development and to public areas, including parks, streets and lanes,

(c) to minimise the adverse impact of development on heritage items, heritage conservation areas and areas of scenic or visual importance,

(d) to nominate heights that will provide a high quality urban form for all buildings and a transition in built form and land use intensity. (cl.4.3)

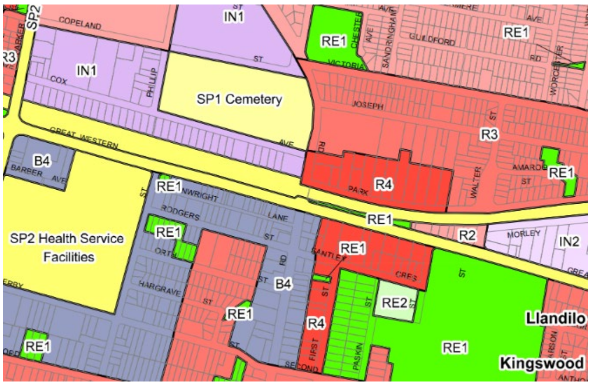

FIGURE 2-3 PENRITH LEP ZONING IN THE VICINITY OF THE SITE

FIGURE 2-4 PENRITH LEP BUILDING HEIGHTS IN THE VICINITY OF THE SITE

3.2.3. Penrith Development Control Plan 2010

This DCP supports the provisions of the Penrith LEP by providing additional objectives and development controls to guide and enhance development within Penrith.

Landscape Design

The DCP says landscape design should:

- '*enhance the amenity and visual quality of the site*'
- '*screen and enhance visually obtrusive land uses or building elements within their setting*' and
- be '*responsive to the bulk and scale of the development*'
- '*highlight architectural features, define entry points, indicate direction, and frame and filter views into the site*'
- Remnant native vegetation '*should be retained, managed and incorporated into landscape designs*' (s.C6, 6.1.3 and 6.1.4).

Industrial development

The Proposal site is located in the Kingswood industrial precinct. Objectives for industrial development (s. D4) include:

(d) promote development of a visually attractive form, design and scale, where urban elements, streetscape and built forms are integrated with the existing environment;

(e) To retain existing vegetation and promote the integration of significant landscaped areas into the site design to minimise the impacts of built form and hardstand areas.

In relation to Building Height, the DCP has the following objective for the industrial development:

> *'To ensure a scale of building which complements the existing environment in which the site is located addressing visibility from key public spaces and the scale and context of the existing and desired streetscape.'* (s. D4, 4.2 B.b)

In relation to Building Setbacks and Landscape, the DCP has the following objectives:

a) To enhance the visual quality of industrial development through appropriate setbacks, building and landscape design, particularly when viewed from public areas;

b) To ensure new development retains existing trees or significant stands of vegetation in the overall site layout; (s. D4, 4.3 A)

In relation to Building Design, the DCP has the following objective for industrial development:

> *'Prominent elevations, such as those with a frontage to the street or public reserves or those that are visible from public areas, must present a building form of significant architectural and design merit. The construction of large, blank wall surfaces is not permitted.* (s. D4, 4.4 B.3)

In relation to lighting, the DCP has the following objectives for industrial development:

a) To encourage the installation of external lighting which does not detract from the appearance of the development or amenity of the locality;

b) To illuminate parts of the site for security reasons and to provide increased safety in accordance with the principles of Crime Prevention through Environmental Design (CPTED) (s. D4, 4.8 A).

Solar Planning

Consideration of solar access and overshadowing of development is identified in section D2, 2.4.9 of the land use controls for residential development (multi dwelling housing), which requires:

> *'The applicant must demonstrate that dwellings meet acceptable solar standards and that existing neighbouring and proposed private open spaces receive adequate solar access by Illustrating the impacts of proposed development upon existing neighbouring dwellings and their open space areas* (D2, 2.4.9).

4. Methodology

4.1. Guidance for landscape and visual assessment

There are no specific legislative requirements for the assessment of landscape and visual assessment in NSW, however, the industry typically refers to the guidance offered by the:

- *Guideline for Landscape Character and Visual Impact Assessment*, *Environmental impact assessment note EIA-N04,* TfNSW (2020)
- *Guidance Note for Landscape and Visual Assessment* (GNLVA), Australian Institute of Landscape Architects Queensland (2018).

The methodology used for this assessment conforms generally with the direction offered by these guidelines.

4.2. Approach

This assessment identifies the potential visual impacts of the Proposal during construction and operations, day and night. The process involved the identification of:

- existing visual conditions
- visual sensitivity
- magnitude of change
- visual impact
- mitigation opportunities.

The potential visual impacts have been classified according to the impact significance criteria set out in this methodology.

4.3. Method

4.3.1. Identification of existing visual conditions

The key landscape features of the site have been identified and described in Section 5.1.

A number of viewpoints have been selected to illustrate the visual influence of the Proposal. These views represent publicly accessible viewpoints from a range of locations and viewing situations.

Particular attention was paid to views from places where viewers are expected to congregate such as Kingswood Station, as well as views to and from nearby streets. The selection of these viewing locations aligns with the 'Site Planning' section of the Penrith DCP 2010 (s.C1, 1.1) which identifies the need to '*Protect, maintain and enhance views and vistas from vantage points, including main road corridors and other public places'* (s.C1, 1.1.2).

4.3.2. Visual sensitivity

Visual sensitivity refers to the nature of the viewer. Locations where there are higher numbers of potential viewers and where visual amenity is important to viewers can be regarded as having a higher visual sensitivity. In addition, any views recognised by local, state or federal planning regulations would, by nature of their recognition in these documents, increase the sensitivity level of the view.

In order to ensure the assessment of impact is reasonable, the sensitivity of a viewpoint is considered in the broadest context of possible views, from those of national importance through to those considered to have a neighbourhood visual importance. For this reason, the following terminology is used to describe the level of visual sensitivity, see Table 4-1.

TABLE 4-1 VISUAL SENSITIVITY LEVELS

Sensitivity level	Description
High National / State	Heavily experienced view to a national icon, e.g. view to Sydney Opera House from Circular Quay or Lady Macquarie's Chair Heavily experienced view to a feature or landscape that is iconic to the State, e.g. view along the main avenue in Hyde Park.
Moderate Regional	Heavily experienced view to a feature or landscape that is iconic to a major portion of a city or a non-metropolitan region, or an important view from an area of regional open space, e.g. an identified view corridor to a state heritage listed item.
Low Local	High quality view experienced by concentrations of residents and/or local recreational users, local commercial areas, and/or large numbers of road or rail users, e.g. view from a local park or gathering space, such as from Penrith General Cemetery or Kingswood Station.

Sensitivity level	Description
Negligible Neighbour-hood	Views where visual amenity is not particularly valued by the wider community such as views from local streets.

4.3.3. Magnitude of change

The magnitude level describes the extent of change resulting from the Proposal and the compatibility of this change with the existing view. There are some general principles which determine the magnitude of change; these include elements relating to the view itself such as distance, landform, backdrop, and contrast. There are also characteristics of the development such as: scale, form and line/alignment. Changes can result in an improvement or reduction in visual amenity.

A high magnitude of change would result if the development contrasts strongly with the existing view. Whereas a low magnitude of change occurs if there is a high level of integration of form, line, shape, pattern, colour or texture values between the development and the environment in which it is located.

In some circumstances, there may be a visible change to a view which does not alter the amenity of the view, this would be where a view has a high visual absorption capacity and / or the development has a high level of compatibility with the surrounding visual context.

Table 4-2 lists the categories used to describe the magnitude of change.

TABLE 4-2 VISUAL MAGNITUDE LEVELS

Magnitude level	Description
High Considerable reduction or improvement in visual amenity.	Substantial part of the view is altered. The Proposal contrasts substantially with surrounding landscape, is not compatible, or substantially detracts from the amenity of the view. Or the proposal substantially enhances the amenity of the view.
Moderate Moderate reduction or improvement in visual amenity.	Alteration to the view is clearly visible. The Proposal contrasts noticeably with surrounding landscape, is moderately compatible or detracts somewhat from the amenity of the view.
Low Minor reduction or improvement in visual amenity.	Alteration to the view is visible. The Proposal contrasts somewhat with surrounding landscape, is mostly compatible or detracts slightly from the amenity of the view.
Negligible Neutral change in visual amenity	Either the view is unchanged or if it is, the change in the view is either unlikely to be perceived by viewers, or the Proposal is compatible with the surrounding landscape and causes no reduction in the amenity of the view.

4.3.4. Identifying night time visual impacts

The assessment of night-time impact has been carried out with a similar methodology to the daytime assessment. However, the assessment also draws upon the guidance contained within *AS4282 Control of the obtrusive effects of outdoor lighting* (2019).

AS4282 identifies four main potential effects of lighting, which are, the effects on residents, transport system users, transport signalling systems and astronomical observations. Of relevance to this assessment is the effects of lighting on the visual amenity of residents and transport system users.

AS4282 identifies environmental zones which are useful for categorising night-time landscape settings. The following assessment will use these environmental zones to describe the existing night-time visual condition and assign a sensitivity to these settings.

These zones are:

- **High** - A0 / A1: Dark / Intrinsically dark landscapes – national parks, state forests etc.
- **Moderate** - A2: Low district brightness areas – rural, small village, or relatively dark urban locations
- **Low** - A3: Medium district brightness areas – small town centres or urban locations
- **Negligible** - A4: High district brightness areas – town/city centres with high levels of night-time activity.

The level of impact on the precinct has been described according to the impact levels that are identified in Table 4-4.

4.3.5. Mitigation measures

Following the identification of potential landscape and visual impacts, opportunities for mitigation have been identified to minimise impacts. Mitigation measures considered included opportunities to avoid, reduce and/or manage potential adverse impacts during construction and operation of the Proposal.

4.3.6. Assigning impact levels

An impact visual impact level has been determined by combining the sensitivity and magnitude level. The following criteria have been used, refer to Table 4-3.

4.3.7. Assessment of Urban Design and Landscape Character Impacts

An assessment of Urban Design and landscape character impacts has been undertaken by responding to the urban design considerations articulated in the Penrith DCP 2010.

This includes consideration of impacts the Proposal would have on the urban design functionality of the site and surrounds, including:

- accessibility, legibility and permeability
- direct impacts on trees, open space and public realm areas
- changes to the level of shade and comfort to public areas
- access to sunlight and the effect of overshadowing.

For the assessment of overshadowing, *the State Environmental Planning Policy No 65 - Design Quality of Residential Apartment Development (SEPP 65)* has been used for guidance. The SEPP includes an Apartment Design Guide which at Objective 4A-1 (page 79) which says:

'Living rooms and private open spaces of at least 70% of apartments in a building receive a minimum of 2 hours direct sunlight between 9 am and 3 pm at mid winter in the Sydney Metropolitan Area'.

TABLE 4-3 VISUAL IMPACT LEVELS

	Sensitivity:			
Magnitude level	High	Moderate	Low	Negligible
High	High	High-moderate	Moderate	Moderate-low
Moderate	High-moderate	Moderate	Moderate-low	Low
Low	Moderate	Moderate-low	Low	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible
Improvement	High benefit	Moderate benefit	Low benefit	Negligible

5. Assessment of visual impacts

5.1. Existing conditions

The Proposal site ('the site') is located at the corner of Cox Avenue and Richmond Road and currently occupied by an at-grade car park. The car park is accessed via both Richmond Road and Cox Avenue.

There are no trees within the car park nor the verges adjacent to the site, along Cox Avenue and Richmond Road. There is a hedge of shrubs within the western edge of the site, and a group of mature, mostly native, trees located immediately south of the car park, within the southern part of the Proposal site (refer to Figure 5-1).

Figure 5-1: Existing trees along the southern site boundary adjacent to the rail corridor

Kingswood Station and the T1 rail corridor is located to the south of the Proposal site. The station consists of two at-grade side platforms and an overbridge with lifts and stairs, providing access to the platforms and surrounding areas. There are accessible pathways, amenities and interchange facilities throughout the station precinct. The southern and northern station entrances are located at the Great Western Highway (refer to Figure 5-2) and at the corner of Park Avenue and Richmond Road (refer to Figure 5-3) which include bus interchange and kiss and ride facilities.

Further to the south, The Great Western Highway (A44) is located directly south of Kingswood Station. It has three traffic lanes in each direction, separated by a raised centre median strip with street tree planting. There is a mix of commercial uses to the south of the highway, as well as several apartment buildings with ground level retail uses (refer to Figure 5-4). The upper levels of the north-facing units in these buildings would have elevated views over the station and Proposal site, to Penrith General Cemetery and suburban areas of Cambridge Park.

Figure 5-2 Southern Entry to Kingswood Station

Figure 5-3 Northern entry to Kingswood Station at corner of Park Avenue and Richmond Road

Figure 5-4 Mid-rise apartment buildings along Great Western Highway, overlooking rail corridor and station

There are single storey light industrial buildings adjoining the western boundary of the site (refer to Figure 5-5). This industry extends along the southern site of Cox Avenue, between Richmond Road and Parker Street.

To the north of the site, the Penrith General Cemetery extends west from the corner of Richmond Road Cox Avenue to Philip Street (refer to Figure 5-5). This area incudes expansive lawn areas, mature trees, footpaths, and internal access roads, with the main entrance located to the west, on Phillip Street. The cemetery is a local heritage item (Penrith LEP 2010).

Figure 5-5 View to industrial properties along Cox Avenue, adjacent to the Proposal site

Figure 5-6: View to Penrith General Cemetery, opposite Proposal site

Figure 5-7: view along Richmond Road to St Joseph's Primary school

Figure 5-8: Three storey apartments and townhouses on Richmond Road

To the north east of the site, St Joseph's Primary School is located at the corner of Richmond Road and Joseph Street (refer to Figure 5-7). The school is located on elevated land, so that western parts of the school, including the church and grounds, would have views towards the site filtered by mature trees within the school grounds and along the street.

To the east of the site, there are two and three storey apartment and townhouse buildings, on the eastern side of Richmond Road (refer to Figure 5-9). The two apartment buildings on the corner of Park Avenue are orientated north south, with the main living spaces orientated north, away from the site. The three townhouses at the end of Cox Avenue, are orientated west, including front gardens and balconies that would have views to the site.

5.2. Assessment of representative viewpoints

The following viewpoints were selected to represent the range of views to the site and the Proposal:

- Viewpoint 1: View southwest from Richmond Road
- Viewpoint 2: View southeast from Penrith General Cemetery
- Viewpoint 3: View west from Park Avenue
- Viewpoint 4: View northeast from Great Western Highway

The location of these viewpoints is shown on Figure 5-9, and an assessment of each viewpoint is summarised in the following sections.

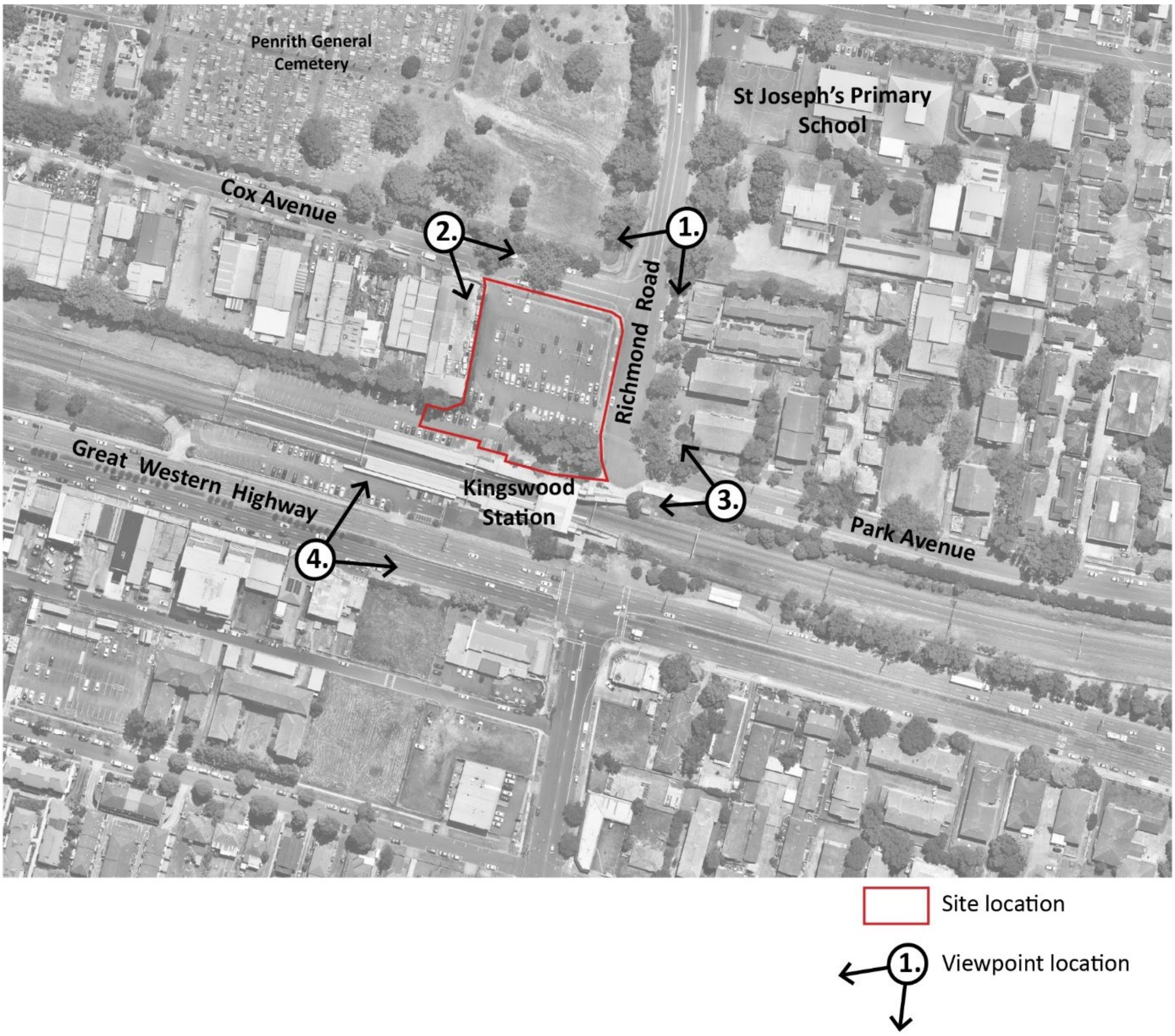

FIGURE 5-9 VIEWPOINT LOCATION PLAN

5.2.1. Viewpoint 1: View southwest from Richmond Road

FIGURE 5-10 VIEWPOINT 1: VIEW SOUTHWEST FROM RICHMOND ROAD

Existing view: This view is located on Richmond Road, north of Kingswood Station, near the Cox Avenue intersection. The existing at-grade commuter car park is visible in the middle ground of this view, accessed at Richmond Road (left of view) and Cox Avenue (right of view). There is a group of mature trees at the southern edge of the car park, and a row of shrubs along the western edge, partially screening views to the adjacent industrial lot.

The Kingswood Station can be seen glimpsed through the trees, to the south, including the station footbridge, lifts and stairs. The existing bus shelter, taxi stop and kiss and ride zone are also visible beside the entrance, at the corner of Park Avenue and Richmond Road. The commercial buildings and several taller apartment buildings, to the south of the station can be seen in the background, rising above the intervening vegetation and station structures.

Visual sensitivity: This view is of **local (low)** visual sensitivity as it is a path near to and leading from Kingswood Station. It would be used by locals and visitors using the station and nearby areas including residences, the local school and cemetery.

Visual impact during construction: A construction site would be established on the site, in the centre of view. The site would be secured by temporary fencing, and hoarding that may partially screening views to the ground level construction activity. Construction of the car park would be visible, rising above the site and construction vehicles would be seen entering and departing the site via Richmond Road.

About 27 trees at the southern boundary of the site would be removed. There would, however, be about nine trees in this area that would be retained. These trees would be gradually screened by the construction of the car park structure as it rises to five levels. The bus shelter beside the station entrance would be removed.

Overall, the scale and intensity of construction, including tree removal, would contrast with the leafy suburban character of this view. There would be a moderate magnitude of change and a **moderate-low visual impact** during construction. This impact would be for a short duration and temporary.

Visual impact during operation: The multi-level car park building would be rise five levels and be seen in the context of the structures at the Kingswood Station. The northern façade of the structure would be set down, about two metres lower than the existing ground level along Cox Avenue. The car park would be enclosed by mesh screening, which would reduce the visual bulk of the structure and filter views to vehicles located within the car park.

Along the eastern side of the car park structure, extending along Richmond Road, the main car park entry and egress point would be located centrally along the structure. There would be a space provided for future ground level retail at the southern end of the building. An awning would extend out from the building over a new kiss and ride / bus waiting area, with seating and new paving between the car park building and station entrance. This area would create a more spacious and visually prominent entrance to the station.

There would be new landscaping along the verge of Richmond Road and Cox Avenue, including street trees, low feature planting beds and turf, as well as new paving, seating and signage. This would improve the visual appearance of the station entrance and streetscape. Several mature trees beside the station entrance would be retained and supplemented with a new garden bed, which would refresh the station entrance and contribute positively to the streetscape character.

Although the new car park would be of much larger mass and scale that the existing industrial and residential buildings surrounding the site, the height of the structure would rise to between about 14-16 metres above ground level, only slightly higher than the 12-metre development height identified for this site in the Penrith LEP 2010.

The visual mass and scale of this structure would be reduced by the folded mesh screening that would surround façade. There would also be planter boxes on the façade and the plants would visually soften the visual bulk of the structure over time.

While the car parking structure would be large scale, the architectural treatment and proposed landscape works to the streetscape would improve this view and general appearance of the station entrance. Overall, there would be a negligible magnitude of change and a **negligible visual impact**.

5.2.2. Viewpoint 2: View southeast along Cox Avenue

FIGURE 5-11 VIEWPOINT 2: VIEW SOUTHEAST ALONG COX AVENUE

Existing view: This view is located on Cox Avenue, alongside the cemetery, northwest of Kingswood Station. The existing commuter car park is in the middle ground of this view, with a driveway access and egress point at Cox Avenue (centre of view). The industrial lot adjacent to the site (right of view) includes a low-rise building with a painted concrete blockwork façade along the street.

The two and three storey brick apartments and townhouses along the eastern side of Richmond Road can be seen in the background of view. The mature trees within the cemetery, along Richmond Road and at the southern end of the car park give this view a leafy character.

Visual sensitivity: This section of Cox Avenue is used by local residents and visitors to this suburban part of Kingswood, including visitors to the cemetery. Views from this area are of **local (low)** visual sensitivity.

Visual impact during construction: A construction site would be established in the middle ground of this view, at the site of the existing car park. Temporary fencing and hoarding would be installed around the perimeter of the site, alongside Cox Avenue, blocking views to the ground level construction activity. Construction of the upper levels of the car park would be visible above the fence line, gradually rising to five levels in height.

While the scale and intensity of construction would contrast with the partly suburban and leafy character of this view, it would be somewhat compatible with the industrial development also addressing Cox Avenue, which includes larger scale buildings with larger vehicle circulation areas.

Overall, there would be a low magnitude of change and a **low adverse visual impact** during construction. This impact would be for a short duration and temporary.

Visual impact during operation: The multi-level car park building would be prominent in the middle ground of this view, rising to five levels, stepping up from the adjacent built form of the industrial area.

The architectural treatment of the façade, including angled steel mesh panels, would provide visual interest, breaking down the scale of the northern and western façades of the structure. This façade treatment would also filter and partly screen the view to the vehicles within the parking structure.

Other elements of the design, including the incorporation of planter boxes with climbing plants into the facade, and new street trees along Cox Avenue, would further soften and filter views to the car park building increasingly over time.

Overall, the car parking structure would introduce large scale built form that would be absorbed into the setting of other larger scale built form. The contrast in scale would be offset by the design treatments and landscaping so that there would be a negligible magnitude of changes and a **negligible visual impact**.

5.2.3. Viewpoint 3: View west from Park Avenue

FIGURE 5-12 VIEWPOINT 3: VIEW WEST FROM PARK AVENUE

Existing view: This view is located on Park Road, west of Kingswood Station. The station bus stop and kiss and ride zone are seen in the view foreground, including shelters and seating, providing a waiting space for commuters. The northern station entrance is located in the middle ground of view, including the entry pathway, lift structures, ramps and stairs.

The existing commuter car park can be seen to the north (right of view), accessed at Richmond Road (centre of view). There is a group of mature trees between the rail corridor and car park, including several large eucalyptus trees. This vegetation, along with the trees is nearby streets, gardens and at the cemetery provide a somewhat leafy character to this view. A small linear commuter car park is also visible in the background of view, beyond the bus shelter and station entrance.

Low-rise industrial buildings are visible in the background of this view, rising above a row of shrubs and fence along the western edge of the car park. Further to the north, is the Penrith General Cemetery, including an elevated area of open space with groups of mature trees.

Visual sensitivity: This view is near the entrance to Kingswood Station, generally experienced by locals and visitors using the station, local bus stops and accessing nearby residences. This view is of **local (low)** visual sensitivity.

Visual impact during construction: A construction site would be established in the centre of view, at the at-grade car park. Several trees between the car park and station would be removed, including about 27 trees of the about thirty trees in this area. The bus shelter and pavements north of the station entrance would also be removed, including the narrow pathway linking to the northern station platform. The eastern part of the linear car park, in the background of view, would be used as a compound during construction. The remainder of this car park would remain open for use and accessed via a temporary driveway from Richmond Avenue, in the centre of this view.

The site would be enclosed by temporary fencing and hoarding, partially screening views to the ground level construction activity. Construction of the car park structure would be visible, rising above the site to about five storeys. Construction vehicles would be seen approaching and departing the site via Richmond Road, and crossing the view

Overall, the scale and intensity of construction, including the removal of several mature trees, would contrast with the leafy suburban character of this view. There would be a moderate magnitude of change and a **moderate-low adverse visual impact** during construction. This impact would be for a short duration and temporary.

Visual impact during operation: The multi-level car park building would be a new feature in the middle ground of this view, rising to about five levels above Richmond Road. From this location, the main car park entry and egress point would be centrally located along the eastern façade of the structure. An allowance for future ground level retail space would be seen at the southern end of the building, beside the station entrance, with an awning extending out from the building over a new kiss and ride / bus waiting area.

The area between the car park and station entrance would be upgraded with new pavements, signage and landscaping, providing a more spacious and well-defined entrance to the station.

There would be a new upgraded streetscape treatment along the verge of Richmond Road, including street trees, low feature planting beds, turf, and a new footpath. This would improve the visual appearance of the streetscape and approach to the station entrance.

Several mature trees to the south of the car park would be retained and supplemented with new garden beds which would refresh the station entrance and contribute positively to the streetscape character.

While the new car park would be of much larger mass and scale that the existing industrial and residential buildings surrounding the site, the structure would be enclosed by folded steel mesh panels, which would provide visual interest, reduce the visual bulk of the structure and filter views to vehicles located within the car park. There would also be planter boxes installed along some sections of the upper façade, incorporating climbing plants that would further soften the façade of the structure over time.

Overall, while the Proposal would introduce a large new building prominently into this view, there is the capacity for this view to absorb this change due to its location adjacent to the larger scale station buildings. Overall, there would be a negligible magnitude of change, and a **negligible visual impact**.

5.2.4. Viewpoint 4: View northeast from Great Western Highway

FIGURE 5-13 VIEWPOINT 4: VIEW NORTHEAST FROM GREAT WESTERN HIGHWAY

Existing view: This view is from the commercial area along the Great Western Highway, southwest of Kingswood Station, which includes apartment buildings with ground level retail uses. This section of the highway includes several lanes of traffic, separated by a fenced median zone. The station is generally level with the road with the station platforms, canopies, footbridge, lifts, ramping structures, and stairs can be seen in the centre of this view. There is considerable visual clutter along the rail corridor including overhead wires and associated equipment, light posts, fences. The station structures, particularly the canopy structures and footbridge, and cars in the southern commuter car park which partially block views to the northern car park site from this location.

There is considerable movement in this view, from vehicles travelling in each direction along the highway, and trains intermittently approaching and departing the station.

This view has a vegetated backdrop including mature trees along the edges of the commuter car parks, along local streets, within Penrith General Cemetery and in the ground of St Joseph's Primary School. This vegetation provides a leafy setting to the station.

Visual sensitivity: Kingswood Station is a local visual landmark, and the surrounding local centre along the Great Western Highway provides a gathering place for residents and visitors. Views from this location are of **local** visual sensitivity.

Visual impact during construction: A construction site would be established in the background of view, at the northern at-grade car park. About two thirds of the existing mature trees between the car park and station would be removed, reducing the leafy canopy in this area. The ground level construction activity would be screened in the view by the intervening canopies along the station platforms and stairs. In the latter months of construction, the car park structure would be visible, rising above the site fencing up to about five levels, in the background of view.

Overall, there would be a low magnitude of change and a **low visual impact** during construction. This impact would be for a short duration and temporary.

Visual impact during operation: Part of the southern façade of the car park structure would be visible in the centre, middle to background of this view, at a distance of over 100 metres. The structure would be seen behind the station and partially blocked and filtered by the station canopy structures and remaining trees. The car park would be set back from the rail corridor and seen in the context of the existing rail corridor infrastructure and the at-grade commuter car parks to north and south of the station. The structure would rise about five levels, obstructing views to some of the vegetation within the cemetery.

This new built form would be seen in the context of the existing station, and while the leafy setting of the station would be reduced in this area, the Proposal would be compatible with the character of the station. Overall, there would be a neutral magnitude of change and a **negligible visual impact** during operation.

5.3. Views at night

Existing conditions:

Areas in the vicinity of the Proposal site are of **medium district brightness (Low visual sensitivity)**, with low visual sensitivity. This is due in part to the brightly lit streets, commuter car park areas, station and retail frontage on the Great Western Highway, as well as the surrounding low to medium density residential development.

The headlights from traffic on Richmond Road, Cox Avenue and particularly the Great Western Highway also contribute to the night-time brightness of this area.

Visual impact during construction: During construction, the construction site and adjacent compound would be lit for security. However, it is unlikely that the site would be used on an ongoing basis for construction activity during evening hours. Generally, the character of the construction works and support sites at night would be visually absorbed into the surrounding brightly lit environment.

This would result in a negligible magnitude of change and a **negligible visual impact** during construction.

Visual impact during operation: During operation, the multi-storey car park and surrounding public domain would be brightly lit at night for safety. This would include motion sensor lighting as required inside the five-level structure, and lighting of the plazas, footpaths, and streets surrounding the structure, and connecting with the station and.

The new car parking structure would be seen within the context of the existing brightly lit Kingswood Station and existing street lights along adjacent streets. The project would, however, extend this brightly lit character of the station closer to the residential areas to the north and east of the station.

The proposed lighting would use technologies to minimise light spill (trespass). The design of barriers and mesh screen panels within the structure and on the façade, have also been designed to block vehicle headlights from within the structure.

While the project would incorporate measures to minimise light spill and prevent direct light intrusion onto surrounding properties, it is likely that there would be some additional skyglow seen above the site and a direct view to additional light sources from the residential buildings to the east of the site.

The car park would increase the height and intensity of the light along Richmond Road, where there would currently be views to relatively low-level lighting at an at-grade car park, from dwellings in this street.

Generally, the character of the proposed multi-storey car park at night would result in a low magnitude of change in views within this locality at night, resulting in a **low adverse visual impact** during operation.

5.4. Summary of visual impacts

The following summarises the findings of this viewpoint assessment.

During construction there would be **low** and **moderate-low visual impacts** in views from nearby streets including Cox Avenue, Richmond Road and Park Avenue. This is due to the proximity of the proposed construction site to these locations and intensity of construction activity. From other locations the visibility of the proposed construction works would be limited or viewed at a distance, and the potential visual impacts would be **negligible**, including views from the Great Western Highway.

During operation there would be a **negligible visual impact** in views from nearby streets. Although the massing and scale of the commuter carpark would be larger than the adjacent industrial and residential buildings, the architectural detail on the façade, including steel mesh panels and vertical planting, would reduce the visual bulk of the structure. The new plaza area to the south of the structure, including a spacious plaza area with new pavements, landscaping, signage and seating, would improve the visual appearance of the station entrance. The retention of some trees and supplementary areas of planting would also assist in integrating the new structure into this location.

Table 5-1 provides a summary of the daytime viewpoint assessment.

At night there would be a **negligible visual impact** during construction as there would as night works would not be required. However, during operation, there would be a **low visual impact** due to the 24-hour operation of the proposed car parking structure, seen within an area which is relatively brightly lit (medium district brightness).

TABLE 5-1 SUMMARY OF DAYTIME VISUAL IMPACT

			Construction		Operation	
	Viewpoint number and location	Sensitivity	Magnitude of change	Visual impact	Magnitude of change	Visual impact
1	View southwest from Richmond Road	Low	Moderate	Moderate-low	Negligible	Negligible
2	View southeast along Cox Avenue	Low	Low	Low	Negligible	Negligible
3	View west from Park Avenue	Low	Moderate	Moderate-low	Negligible	Negligible
4	View northeast from Great Western Highway	Low	Low	Low	Negligible	Negligible

6. Assessment of urban design and landscape impact

6.1. Response to urban design guidelines

Table 6-1 provides a summary of how the Proposal has responded to a selection of the most relevant landscape and urban design considerations identified in section 3 (Planning context) of this report, including local government planning documents (LEP and DCP).

The requirements of these planning instruments have been used as a guide to ensure locally appropriate urban design outcomes are achieved

TABLE 6-1 RESPONSES TO URBAN DESIGN AND LANDSCAPE CHARACTER CONSIDERATIONS

Consideration	Response
Penrith Local Environmental Plan 2010	
Potential Building Heights	
(a) to ensure that buildings are compatible with the height, bulk and scale of the existing and desired future character of the locality,	The desired future character of this area is for increased built form scale as the site is zoned IN1 General Industrial, with building heights identified as up to 12 metres. While the proposal would be slightly higher (up to about 16 metres), the bulk and scale of the structure is compatible with the potential future industrial uses on adjacent sites, as well as the adjacent railway station, which includes recently upgraded structures including lift shafts, a pedestrian bridge, ramping structures and stairs. The materials palette of the Proposal is consistent with the character of the station which includes concrete and steel, and high quality streetscape finishes.
(b) to minimise visual impact, disruption of views, loss of privacy and loss of solar access to existing development and to public areas, including parks, streets and lanes,	The visual impact of the proposal has been assessed in section 5.2, using representative viewpoints from the public domain. This assessment identified negligible visual impacts overall. This includes consideration of the disruption of views to the station from the north and views to the backdrop of trees from the south. The steel mesh panels and planting along the eastern façade would reduce the likelihood for loss of privacy of residences to the east, facing Richmond Road.

Consideration	Response
	Overshadowing or solar access has been assessed in section 6.3. This assessment identified a negligible impact.
(c) *to minimise the adverse impact of development on heritage items, heritage conservation areas and areas of scenic or visual importance,*	The proposal would not impact on the visual qualities and setting of nearby heritage items, including the cemetery. There are no other areas of scenic or visual importance near the site.
(d) *to nominate heights that will provide a high quality urban form for all buildings and a transition in built form and land use intensity*. (cl.4.3)	The use of steel mesh panels around the structure would ensue a lightweight appearance and add transparency, reducing the visually dominance. The use of awnings along the ground level, would allow a pedestrian scale and transition the built form to the station entrance near Richmond Road.
Penrith Development Control Plan 2010	
Landscape Design	
Landscape design should '*enhance the amenity and visual quality of the site*'. Landscaping solutions are to be used to '*screen and enhance visually obtrusive land uses or building elements within their setting'* (s.C6, 6.1.3).	Landscaped areas would be provided around the site boundaries, including a wide area of open space between the car park and adjacent station, comprising new areas of planting to complement the retained mature trees. Streetscape planting along Cox Avenue and Richmond Road would improve the amenity of the street and filter views towards the proposed car parking structure.
Landscape design should be '*responsive to the bulk and scale of the development'.* Landscape design should also be used to '*highlight architectural features, define entry points, indicate direction, and frame and filter views into the site'* (s. C6, 6.1.4).	Planter boxes would be incorporated into the building facades, including climbing plants, that would soften views to and reduce the bulk and scale the structure over time.
Remnant native vegetation '*should be retained, managed and incorporated into landscape designs'* (s. C6, 6.1.4).	A group of trees within the southern part of the site would be retained, including up to about nine trees, which would be incorporated into the design of the northern station entrance.
Industrial Development	
The Proposal site is located in the Kingswood industrial precinct. Objectives for industrial development (s. D4) include:	
(d) *promote development of a visually attractive form, design and scale, where urban elements, streetscape and built forms are integrated with the existing environment;*	The Proposal would include public domain improvements such as new paving, planting, furniture, bicycle parking, signage and lighting.
(e) *To retain existing vegetation and promote the integration of significant landscaped areas*	A group of trees within the southern part of the site would be retained, including up to about nine trees, which would be

Consideration	Response
into the site design to minimise the impacts of built form and hardstand areas.	complemented by new garden beds, improving the visual appearance of the northern station entry.
In relation to Building Height, the DCP has the following objective: *'To ensure a scale of building which complements the existing environment in which the site is located addressing visibility from key public spaces and the scale and context of the existing and desired streetscape.'* (s. D4, 4.2 B.b)	While the scale of the structure would be larger than adjacent industrial and residential buildings, the use and form of the proposed steel mesh panels and integration of planter boxes within the façade would reduce the visual dominance and bulk of the building. As well as providing an attractive façade on all sides, to address adjacent areas of public domain, the streetscapes would be further improved by street trees, garden areas and improved pavements.
In relation to Building Setbacks and Landscape, the DCP has the following objectives: *a) To enhance the visual quality of industrial development through appropriate setbacks, building and landscape design, particularly when viewed from public areas;* *b) To ensure new development retains existing trees or significant stands of vegetation in the overall site layout;* (s. D4, 4.3 A) In relation to Building Design, the DCP has the following objective: *'Prominent elevations, such as those with a frontage to the street or public reserves or those that are visible from public areas, must present a building form of significant architectural and design merit. The construction of large, blank wall surfaces is not permitted.* (s. D4, 4.4 B.3)	The proposed car parking structure would be set back from Cox Avenue and Richmond Road, including a wide verge containing street trees, low feature planting and lawn areas, improving the streetscape character and filtering views to the structure from the street and adjacent neighbourhood. The building would be set back from the station by a large area of open space, incorporating existing mature trees and new areas of planting, improving the character of this area. Each facade of the structure has been articulated with steel mesh screen panels, with varying angles, adding texture and visual transparency to the structure, and reducing the visual bulk.
In relation to lighting, the DCP has the following objectives: *a) To encourage the installation of external lighting which does not detract from the appearance of the development or amenity of the locality;* *b) To illuminate parts of the site for security reasons and to provide increased safety in accordance with the principles of Crime Prevention through Environmental Design (CPTED) (s. D4, 4.8 A).*	Lighting would be designed for the safe use of the Proposal and surrounding areas at night, highlighting station and car park entries to improve wayfinding and legibility, as well as minimise light spill. CPTED has been incorporated into the design of the structure and public domain areas.

6.2. Urban design and landscape character impacts

The following assessment considers the urban design and landscape character impacts of the Proposal on the Proposal site and setting.

Urban design and landscape character impacts during construction:

During construction, the at-grade car park would be closed and removed. The removal of mature trees and shrubs in the southern part of the site, including up to about 27 trees would reduce the leafy character in this location.

The eastern end of the northern linear commuter car park would be used as a compound, including site offices and a laydown area beside the site. The compound and construction site would be accessed via existing driveways on Cox Avenue and Richmond Road.

Local pedestrian routes around the site may be temporarily diverted. The pathways adjacent to the site, along Cox Avenue and Richmond Road would be closed. Although the northern station entrance would remain open, including the stairs, lifts and ramping structure, there would be temporary pedestrian access arrangements and footpath diversions in this area north of the station, which would reduce the legibility and accessibility of the station from Richmond Road and Park Avenue. There would also be reduced amenity and comfort for pedestrians using the station platforms, particularly the northern platform, due to the tree removal and use of large-scale machinery.

Overall, there would be a temporary moderate reduction in the landscape and urban design functionality and landscape character of the station precinct and proposal site, during construction. This precinct is of local sensitivity and there would be a **moderate-low landscape impact**.

Urban Design and landscape character impacts during operation: During operation, there would be considerable improvements to accessibility north of the station, with the introduction of a new multi-level commuter car park adjacent to the station, with about 300 extra parking spaces, including accessible car parking, lift access and bicycle parking. The existing linear commuter car park would be retained and accessed via the new car park.

There would be a wide area of public realm located between the station and car park, including several existing mature trees, complemented by new garden beds, paving, seating, signage and lighting, improving the legibility and appearance of the northern entrance to the station. The existing bulk storage / refuse area would be relocated, improving the visual appearance and accessibility of this area. New street trees would be installed along Cox Avenue and Richmond Road, providing shade and comfort to customers accessing the car park and station.

An architectural mesh screening system to the building façade and the provision of additional landscaping (attached to the building and within the areas of public realm) would also positively contribute to the streetscape and pedestrian environment the station precinct, including the site.

Overall, there would be a moderate improvement to the urban design functionality and landscape character of the station precinct, resulting in a **beneficial landscape impact** during operation.

6.3. Potential for overshadowing

Overshadowing is a potential impact related to good urban design outcomes.

In *Penrith Development Control Plan 2010*, consideration of solar access and overshadowing of development is identified in section D2, 2.4.9 of the land use controls for residential development (multi dwelling housing), which requires:

'The applicant must demonstrate that dwellings meet acceptable solar standards and that existing neighbouring and proposed private open spaces receive adequate solar access by Illustrating the impacts of proposed development upon existing neighbouring dwellings and their open space areas (D2, 2.4.9).

Figure 6-1 shows the potential worst-case overshadowing that would occur during winter, at 9am, noon and 3pm.

This includes the following residential properties and locations:

- Kingswood Station would experience overshadowing during winter months at different times of the day, due to the close proximity and height of the car park structure. The platforms and northern commuter car park would be shaded during the morning, while the northern station entrance, including the stairs, ramping structure and stairs would be shaded in the afternoon. The majority of the open space located between the station and car park structure would be shaded during winter months, as seen in Figure 6-1.
- The dwellings to the east of the site, at 2-10 Richmond Road, would not experience overshadowing during winter months, as seen in Figure 6-1.

Figure 6-1 Potential overshadowing on 21st June, at 9am, noon and 3pm

7. Mitigation of impacts

The following mitigation measures are recommended to be implemented to further reduce and manage the visual and landscape character impacts of the Proposal:

- All permanent lighting would be designed and installed in accordance with the requirements of standards relevant to *AS 1158 Road Lighting* and *AS 4282 Controlling the Obtrusive Effects of Outdoor Lighting.*
- The detailed design of the Proposal would comply with Crime Prevention Through Environmental Design principles.
- Worksite compounds would be screened with shade cloth (or similar material, where necessary) to minimise visual impacts from key viewing locations e.g. from the station.
- Temporary hoardings, barriers, traffic management and signage would be removed when no longer required.
- During construction, graffiti would be removed in accordance with Transport for NSW's Standard Requirements.

In addition, the following mitigation measures should be considered:

- temporary access arrangements should be well signed and provide a visually legible route for pedestrians
- consolidate construction equipment and activity to maximise the area of useable public realm where possible.

8. References

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NSW Government, Transport for NSW, 2017, *Commuter Car Parks: urban design guidelines, Interim issue.*

Transport for NSW, 2020, *Guidance note EIA-N04 Guidelines for Landscape Character and Visual Impact Assessment.*

Appendix F

Light impact assessment

PENRITH CITY COUNCIL

KINGSWOOD COMMUTER CAR PARK

LIGHTING IMPACT ASSESSMENT

JULY 2022

wsp

Question today
Imagine tomorrow
Create for the future

Kingswood Commuter Car Park
Lighting Impact Assessment

Penrith City Council

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REV	DATE	DETAILS
1	13/07/2022	Final
0	14/06/2022	Draft

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Reviewed by:	Fiona Venn	14/06/2022	Fiona Venn

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1 INTRODUCTION

Penrith City Council recognises the critical role commuter car parking plays in improving the quality of access to public transport for customers, particularly in the middle and outer metropolitan areas. Improving public transport for commuters is the focus of NSW Government transport initiatives. Commuter car parks are the gateways to the transport system and play a critical role in shaping customer experience of public transport, making it safe, easy and reliable.

The proposed Kingswood Commuter Car Park (the proposal) involves the construction of a 14 metre (m) high multi-storey car park adjacent to the Kingswood Station. The multi-storey car park would provide approximately 300 additional commuter car parking spaces and integrate into the existing road and pedestrian network.

1.1 THE PROPOSAL

1.1.1 LOCATION

The proposal is located at 6 Cox Avenue, Kingswood on the corner of Cox Avenue and Richmond Road in the Penrith City Council Local Government Area (the proposal site). The new multi-storey car park would occupy the existing at-grade Council car park on Lot 1 DP 198211 which has 115 car parking spaces.

The proposal site is situated directly north of the Kingswood Station approximately 49 kilometres west of the Sydney Central Business District.

Figure 1 Location of the proposal

1.1.2 KEY FEATURES

The key features of the proposal are:

- Removal of the existing at-grade Council car park
- Construction of a multi-storey commuter car park comprising five levels with
  - A minimum of 410 new car parking spaces
  - Approximately four accessible parking spaces on the lower ground floor and ground floor
  - Approximately seven motor bike parking spaces on the lower ground floor
  - Provision of bicycle storage on the lower ground floor
  - Provision for electric vehicle charging stations
  - Solar panels on the rooftop
- Three vehicular access and egress points on Cox Avenue, Richmond Road and through the Transport for NSW at-grade car park Construction of a new shared access road to the Transport of NSW at-grade car park off Richmond Road.
- Ancillary works including services diversion and/or relocation, drainage works, landscaping, installation of lighting, installation of handrails and balustrades and new infrastructure (including wayfinding signage and CCTV cameras).
- The outer walls of the new Kingswood Commuter Car Park multi-storey building will be sheer walls with mesh façade panels to create a 'translucent' feel to the building enhancing a sense of safety and security. The proposal includes planter boxes on the façade panels on the Northeast corner.

Figure 2: Architectural artist impression from N.E.

Figure 3: Architectural artist impression from S.E.

1.1.3 CONSTRUCTION

Subject to approval, construction is expected to commence in Q2 2023 and take approximately 12 months to complete.

The works required for the proposal would be undertaken during standard NSW Environment Protection Authority (EPA) construction hours. Out of hours works may be required in some cases to minimise disruptions to commuters, pedestrians, motorists, and nearby sensitive receivers. Approval from Council would be required for any out of hours work and the affected community would be notified.

Construction of the proposal would require:

- Site establishment and enabling works
- Demolition and site clearing works
- Earthworks including excavation and grading
- Building and structural works
- Installation of architectural features
- Landscaping and ancillary infrastructure
- Testing and commissioning
- Decommissioning of temporary facilities and site demobilisation.

The construction methodology would be further developed during the detailed design of the proposal by the nominated contractor in consultation with Penrith City Council.

1.2 PURPOSE OF THE REPORT

This report has been prepared by WSP Specialist Lighting team as part of the Review of Environmental Factors for the proposal to assess potential lighting impacts during construction and operation.

This lighting impact assessment will provide a technical lighting brief and pragmatic design recommendations for managing and controlling the obtrusive effects of outdoor lighting for the project's night-time lighting to the nearby properties.

The technical aspect of this assessment will summarise relevant design standards applicable to controlling and managing the obtrusive effects of outdoor lighting. The purpose of this assessment is to provide a high-level overview of existing lighting. It will assess the lighting potential impacts associated with the proposal and provide design criteria and design requirement benchmarks for the design of the Kingswood Commuter Car Park lighting to adhere to.

1.3 ARTIFICIAL LIGHTING REQUIREMENTS

The proposed new lighting will consist of lighting to the new Kingswood Commuter Car Park multi-storey building, lighting to the associated pathways and landscape areas, and streetlighting to the sections of street directly surrounding the new car park. It is assumed the proposed streetlighting directly surrounding the car park on Cox Avenue and Richmond Road, as well as the new Kingswood Commuter Car Park will be council owned.

The following lighting considerations have been outlined in a meeting with Sam Crawford Architects and Root Partnerships on April 26, 2022.

- Lighting – The impact of lighting from the development will need to be considered with regards to impacts on the surrounding residential properties and the night sky.
- The area has been identified by Penrith City Council as a high risk of crime area in NSW, based on the NSW Bureau of Crime Statistics and Research. The lighting will need to consider appropriate light levels for safe movement and creating a sense of safety and security at night. Lighting design to be coordinated and include CPTED principles.

1.4 DRAWINGS PROVIDED

The following drawings were provided to WSP to complete a lighting impact assessment of the project site:

- 21.14 Kingswood Commuter Car park - Issued for Information Set, dated 22-04-22, Revision P3 (PDF)

2 EXISTING SITUATION

2.1 SITE AND SURROUNDING AREA DESCRIPTION

To the north of the existing car park the Penrith General Cemetery is located (shown in green). To the east there are the local residences of 8-10 Richmond Road and 80 Park Avenue (shown in magenta and blue). For 80 Park Avenue most windows are facing towards the other buildings, and there are a limited number of windows facing towards the car park (refer to figure 5). 8-10 Richmond Road has several windows facing towards Cox Avenue, most of which are shielded by canopies/balconies (refer to figure 5).

Further east St Joseph's Catholic Parish and Primary School are located (shown in pink). To the west there are currently several commercial properties (shown in orange), with the potential of low-medium density housing developments in the future. To the south Kingswood Station and its associated TfNSW car park (shown in red) are located.

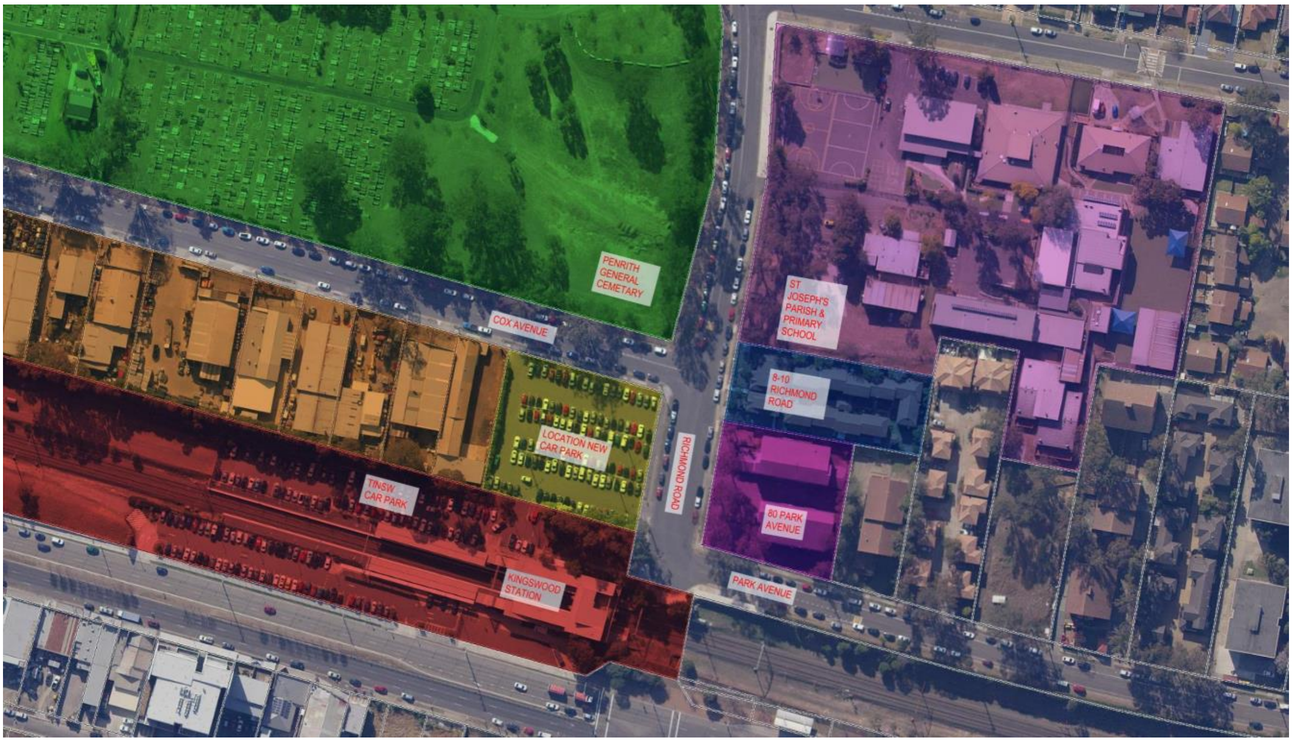


Figure 4: Six Maps capture

Figure 5: Photo of 8-10 Richmond Road, and 80 Park Avenue

2.2 EXISTING LIGHTING

A site visit was conducted on April 21, 2022, between 5.30pm-7pm. The weather conditions were overcast and dry.

2.2.1 EXISTING KINGSWOOD CAR PARK

The existing lighting at the current Kingswood at-grade car park consists of:

— 4 steel poles with 4 outreach arms and lights per pole. The lights appear to be 150W High Pressure Sodium (orange lighting appearance) Sylvania Roadsters mounted at approximately 10.5m height on an outreach arm of approximately 5.8m.

Figure 6: Photo existing car park

2.2.2 ADJACENT STATION & TFNSW CAR PARK

Kingswood Station is brightly illuminated to meet the relevant Australian standards (or other applicable guidelines) at the time of installation. The lighting predominantly consists of:

— Weatherproof battens mounted under the canopy, white light appearance
— Pole top mounted lights on the platform, white light appearance
— Pole top mounted Metal Halide area lights and LED area lights at approximately 8m height to light the TfNSW car park, in combination with Metal Halide area lights mounted to the station canopy at approximately 3m height. All these lights have a white light appearance.
— Pole top mounted Metal Halide area lights, white light appearance at approximately 4m mounting heights for the pathway, in combination with one wall mounted light.
— Timber pole mounted floodlight to light bus shelter across the street on Park Avenue, white light appearance.

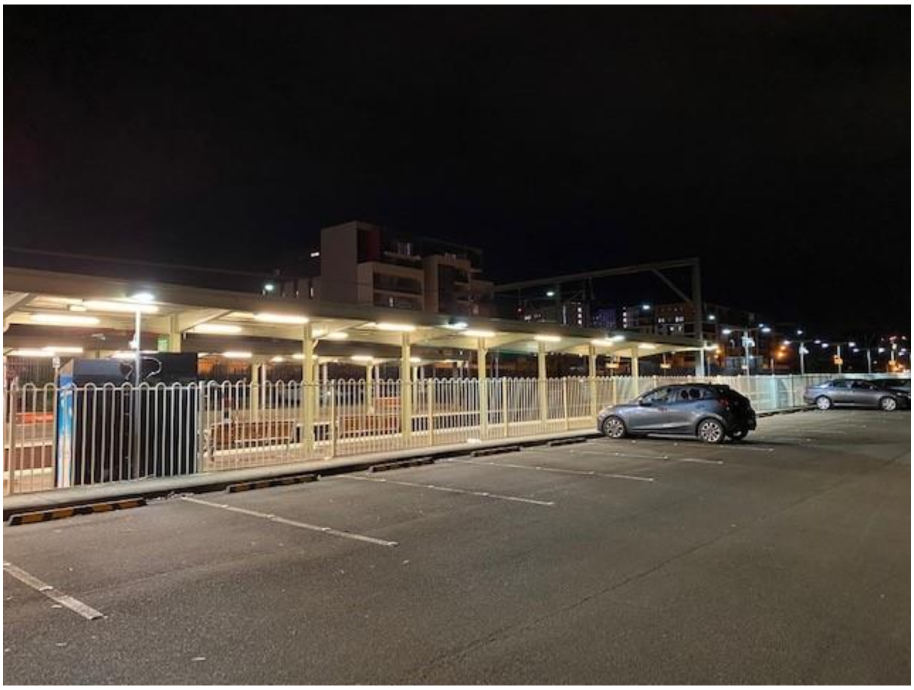


Figure 7: Photo Adjacent Station Platform & TfNSW Car Park

Figure 8: Photo Kingswood Station

Figure 9: Photo Kingswood Station Bus Shelter

Figure 10: Photo Adjacent TfNSW car park

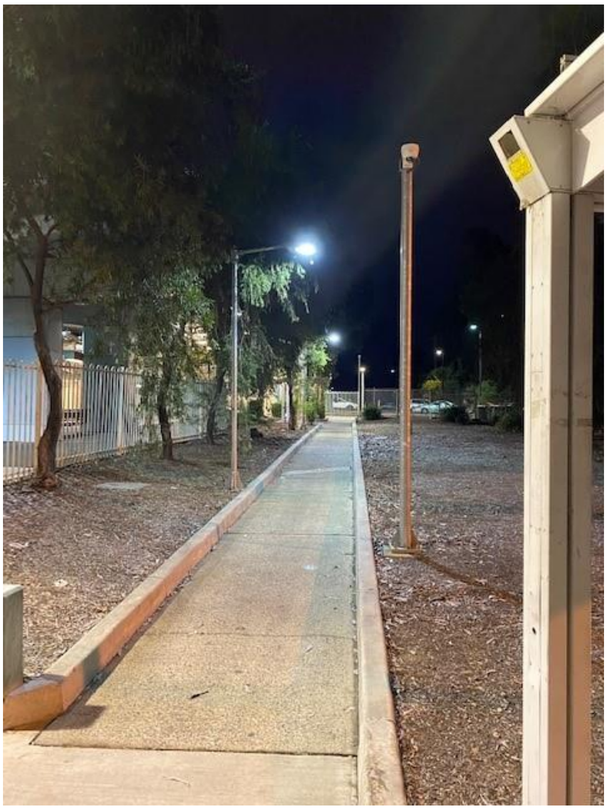


Figure 11: Photo Kingswood Station Pathway

2.2.3 SURROUNDING STREETS

There are three streetlights located near the existing car park, each mounted on existing timber reticulation poles:

- On the corner of Park Avenue and Richmond Road – High Pressure Sodium Roadster (orange light appearance)
- On the corner of Richmond Road and Cox Avenue – High Pressure Sodium Roadster (orange light appearance)
- On Cox Avenue near the existing driveway of the car park – High Pressure Sodium Roadster (orange light appearance)

All three street light poles above are nominated to be removed and replaced with powerlines relocated below ground as per drawing 21.14_SCA_SK_02-P3-GROUND FLOOR.

Further along each street (Park Avenue, Richmond Road and Cox Avenue) the lighting changes to a lower wattage LED luminaire on an outreach with white light appearance, indicating the roads are most likely lit to local road light levels.

Figure 12: Photos streetlights near existing car park

Figure 13: Photos streetlighting further along Park Avenue and Richmond Road

2.2.4 RESIDENTIAL PROPERTIES & CEMETARY

The residential properties have some lighting within the properties themselves consisting of surface mounted lights on the side of the buildings or under canopies/balconies, and low height pole mounted luminaires. The St Joseph's Catholic Parish and Primary School has floodlighting of the grounds/property.

Penrith General Cemetery appears to have no lighting in the area located near the car park.

Figure 14: Photos St Joseph's Catholic Parish & 8-10 Richmond Road

2.3 EXISTING LIGHT LEVELS AND LIGHT APPEARANCE

Various indicative light measurements were taken to get a sense of the existing light levels. The below map illustrates the various apparent brightness (red = high apparent brightness, orange = medium apparent brightness, yellow is low apparent brightness).

Figure 15: Six Maps capture showing brightness

The lighting at Kingswood Station appeared to be the brightest, closely followed by the existing at grade car park. The TfNSW car park appeared to be less bright compared to the existing Kingswood at-grade car park.

The existing at grade car park lighting (and the streetlights directly surrounding the car park) spill onto Richmond Road and Cox Avenue. This results in light spill on the property boundary of the residential properties of 8-10 Richmond Road, and 80 Park Avenue.

A pole mounted floodlight aimed towards the south, illuminates the bus shelter across the street on Park Avenue.

The landscaping between the existing car park and Kingswood Station currently contains large trees and appeared to be unlit, receiving spill lighting from its surrounds. There is a brightly lit pathway along the station leading from the corner of Park Avenue and Richmond Road to the TfNSW car park.

Further along, Park Avenue, Richmond Road and Cox Avenue, the light levels appear lower as these streets are lit by lower wattage streetlights typically used for local roads. The grounds of St Joseph Catholic Parish appear bright where the buildings/grounds are being floodlit (operational hours are unclear).

The commercial properties on Cox Avenue appeared to be dark with minimal lighting.

The measured light levels indicate that the existing car park was lit to at least the highest available subcategory for outdoor car parks: P11a (based on the former Australian standard (2005), equivalent to PC1 latest Australian standard 2020).

3 BENCHMARKING AGAINST RELEVANT STANDARDS

3.1 PENRITH CITY COUNCIL – PUBLIC DOMAIN LIGHTING POLICY – PDAS 003

The Penrith City Council lighting policy outlines the decision-making process for determining appropriate lighting. It refers to Australian Standards AS/NZS 1158 for specific lighting levels.

Since the new multi-storey car park will be located directly next to Kingswood Station, Section 5.5 Transport Facilities is relevant for this application.

Section 5.5 – notes the following:

"All roads, if subject to P Category lighting, footpaths, lanes and alleyways immediately adjacent to a transport facility should have lighting to, at least, Category P3 for security, particularly those access ways from car parks.

For reasons of security it may be warranted to extend higher Category P lighting for a distance along those roads used by pedestrians for access; see Appendix 2.

Such lighting is to convey a feeling of security and encourage the use of the facilities."

There is no specific section for multi-storey car parks, however, Section 5.4 – outlines the following:

"(i) Integration of landscaping and lighting – landscaping of the car park, both peripheral and within the area, shall be laid out so that it does not reduce the specified level of lighting. The landscaping shall conform with Appendix 3 "The integration of trees and public space lighting."

(ii) Obtrusive light – where there are residential dwellings bordering a car park, there shall be no spillage of light beyond the boundaries so that it is not obtrusive to residents."

Appendix 2 details the enhanced lighting for security and prestige policy. Lighting may be used to reduce fear of crime and the potential for actual crime occurrence.

3.2 AS/NZS 4282:2019 – CONTROL OF THE OBTRUSIVE EFFECTS OF OUTDOOR LIGHTING

Australian standard AS/NZS 4282:2019 - Control of the obtrusive effects of outdoor lighting, provides recommendations for the limitation of light spill to adjacent properties. Several aspects of potential obtrusiveness are considered. These include visibility of light falling on surrounding properties, the brightness of luminaires in the field of view of nearby residents and the glare to users of adjacent transport systems. To control of these effects, lighting technical parameters have been developed which take into account the following:

— The level of lighting currently in the area

— The time that the proposed lighting is to operate

— The type of lighting technology available to light the area

General recommendations to reduce external light pollution include:

- Switch lights off when not required for safety, security of enhancement of the night-time scene (i.e. apply a curfew switch-off time)
- Wherever possible, direct light downwards, not upwards, to illuminate the target area.
- Use specifically designed lighting equipment that once installed, minimises the spread of light near to or above the horizontal
- Do not 'over' light
- To keep glare to a minimum, ensure that the main beam angle of luminaires directed towards a potential observer is kept below 70°. It should be noted that the higher the mounting height, the lower the main beam angle can be.
- In places with low ambient light, glare can be obtrusive and extra care should be taken in positioning and aiming
- Wherever possible use floodlights with asymmetric beams that permit the front glass to be kept horizontal or near parallel to the surface being lit

As per the standards, residential developments have stricter restrictions on obtrusive lighting, and the relative brightness of the surrounds must be considered.

Tables 3.1 and 3.2 from AS/NZS 4282:2019 (extract below) shows recommended zone classifications and their relative design parameters.

TABLE 3.1

ENVIRONMENTAL ZONES

Zones	Description	Examples
A0	Intrinsically dark	UNESCO Starlight Reserve. IDA Dark Sky Parks. Major optical observatories No road lighting -unless specifically required by the road controlling authority
A1	Dark	Relatively uninhabited rural areas No road lighting - unless specifically required by the road controlling authority
A2	Low district brightness	Sparsely inhabited rural and semi-rural areas
A3	Medium district brightness	Suburban areas in towns and cities
A4	High district brightness	Town and city centres and other commercial areas Residential areas abutting commercial areas
TV	High district brightness	Vicinity of major sports stadium during TV broadcasts
V	Residences near traffic routes	Refer AS/NZS1158.1.1
R1	Residences near local roads with significant setback	Refer AS/NZS 1158.3.1
R2	Residences near local roads	Refer AS/NZS 1158.3.1
R3	Residences near a roundabout or local area traffic management device	Refer AS/NZS 1158.3.1
RX	Residences near a pedestrian crossing	Refer AS/NZS 1158.4

NOTE: Recreational areas are not considered commercial.

Figure 16: AS/NZS 4282:2019 Table 3.1 Environmental Zones

TABLE 3.2

MAXIMUM VALUES OF LIGHT TECHNICAL PARAMETERS

Zones	Vertical illuminance levels (E_v) lx		Threshold increment (TI)		Sky glow
	Non-curfew	Curfew	%	Default adaptation level (L_{ad})	Upward light ratio
A0	See Note 1	0	N/A	N/A	0
A1	2	0.1	N/A	N/A	0
A2	5	1	20%	0.2	0.01
A3	10	2	20%	1	0.02
A4	25	5	20%	5	0.03
TV	See Table 3.4	N/A	20%	10	0.08
V	N/A	4	Note 2	Note 2	Note 2
R1	N/A	1	20%	0.1	Note 3
R2	N/A	2	20%	0.1	Note 3
R3	N/A	4	20%	0.1	Note 3
RX	N/A	4	20%	5	Note 4

NOTES:

1 For A0, E_v shall be as close to zero as practicable without impacting safety considerations.

2 Refer to AS/NZS 1158.1.1.

3 Refer to AS/NZS 1158.3.1.

4 Refer to AS/NZS 1158.4.

5 N/A means 'Not Applicable'.

Figure 17: AS/NZS 4282:2019 Table 3.2 Light Technical Parameters

3.2.1 AS/NZS 4282:2019 DESIGN PARAMETERS FOR KINGSWOOD COMMUTER CAR PARK

With reference to table 3.1, it is recommended that the future lighting design for Kingswood Commuter Car Park falls under environmental zone A3 – Medium district brightness for suburban areas in towns and cities and complies with the below light technical parameters.

A3 MEDIUM DISTRICT BRIGHTNESS – LIGHT TECHNICAL PARAMETERS

Non-curfew:

Vertical illuminance: 10 lux

Threshold Increment - 20%

Adaption level – 1

Sky glow – 2%

Curfew:

Vertical illuminance: 2 lux

Threshold Increment - 20%

Adaption level – 1

Sky glow – 2%

3.3 AUSTRALIAN STANDARDS – AS/NZS1158 AND AS/NZS 1680

AS/NZS 1680.2.1:2008 outlines the requirements for indoor car parks.

Exterior lighting and associated light level recommendations are outlined in AS/NZS 1158 Series. Specifically, AS/NZS 1158.3.1:2020 details the requirements for P-category lighting.

3.3.1 AS/NZS 1680.2.1:2008

The following table is an extract from AS/NS 1680.2.1:2008 and shows recommended lighting levels and associated design criteria for different areas within an indoor car park.

TABLE D1 (*continued*)

	1	2	3	4	5	6
	Type of interior or activity	**Maintained illuminance lx**	**Lamp colour appearance group**	**Lamp colour rendering group (minimum)**	**Maximum glare index**	**Other recommendations and advice**
11	CARPARKS (INDOORS)					The use of light coloured surfaces will improve the interreflection of light within the space and make obstructions (e.g. columns) more visible to drivers.
11.1	Entrances:					
	(a) During daytime					
	—first 15 m	800	1, 2, 3	2, 3	—	Applies over the path of entering vehicles, from the entry point, to facilitate adaptation of drivers from high external illuminances. Daylight will normally provide the required illuminance for a distance of approximately twice the height of the entrance.
	—next 4 m	160	1, 2, 3	2, 3	—	Applies over the path of the entering vehicles, continuing on from the above, to provide a transition for vehicle drivers to the lower illuminances within the interior of the carpark.
	(b) During night-time	160	1, 2, 3	2, 3	—	The enhanced entry lighting recommended in Item (a) should be automatically reduced at night.
11.2	Pay booths	(see recommendations for Gatehouses under Item 1.4)				
11.3	Aisles, ramps, circulating roads, pedestrian crossings	40	1, 2, 3	2, 3	—	
11.4	Normal parking spaces	40	1, 2, 3	2, 3	—	
11.5	Parking spaces for disabled	40	1, 2, 3	2, 3	—	

1.4	Gatehouses	160	1, 2	2	19	

Figure 18: Extracts from AS/NZS 1680.2.1:2008 Table D

Light levels at the entrances are higher to allow for adaption in moving from an outdoor space to an indoor space during daytime.

3.3.2 AS/NZS 1158.3.1:2020

The main purpose of the P-Category lighting is to assist pedestrians to orientate themselves and detect potential hazards of the area they are in and to reduce fear of crime.

Extract from AS/NZS 1158.3.1: 2020 (figure 2.1), shown in figure 18 on the next page, shows an example of road and public space types and indicative lighting categories and subcategories.

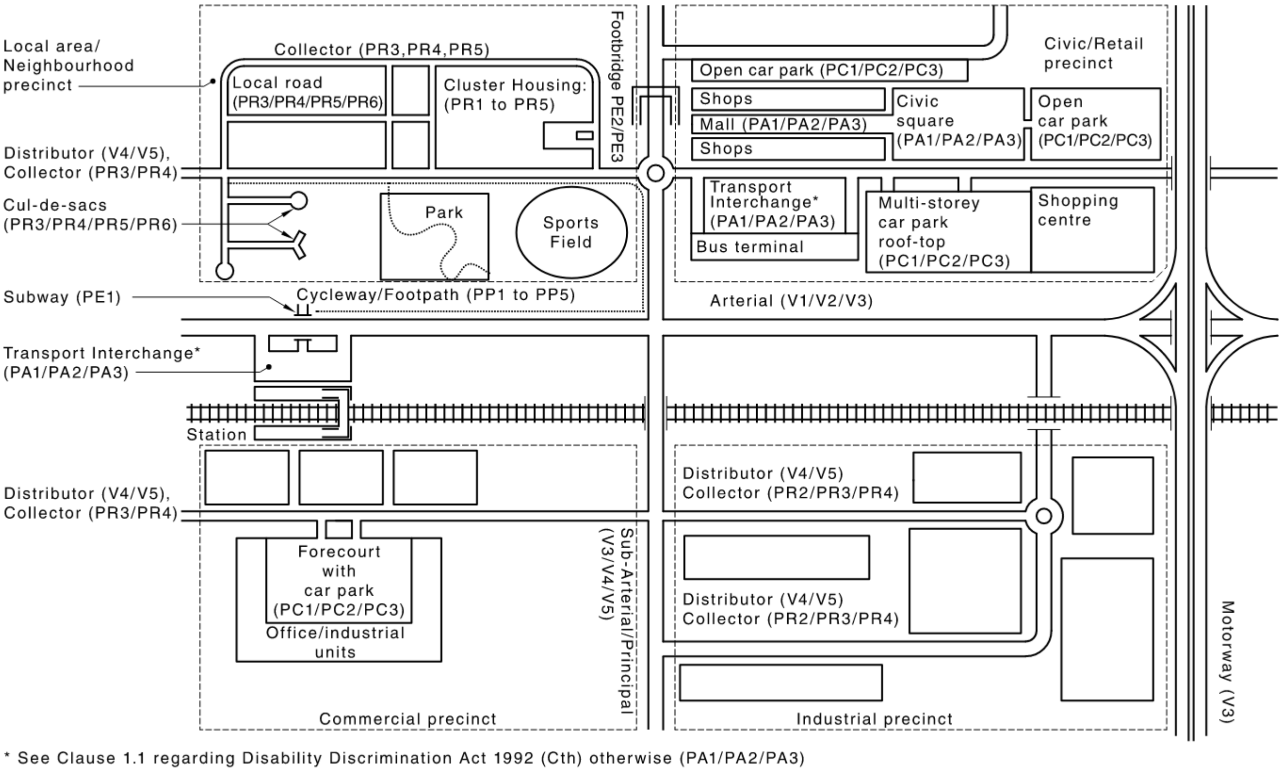


FIGURE 2.1 EXAMPLE OF ROAD AND PUBLIC SPACE TYPES AND INDICATIVE LIGHTING CATEGORIES AND SUBCATEGORIES

Figure 19: Figure 2.1 from AS/NZS 1158.3.1:2020

The principal design objectives for P-Category lighting are to provide the following:

— Illuminance and uniformity of illuminance over the designated area
— Glare control to a specific level
— Limitation of upward light from luminaires to a specified level
— A maintenance regime such that the lighting scheme complies at all times during each maintenance cycle over the life of an installation

Pedestrian/cycle activity, fear of crime, and need to enhance prestige are the selection criteria used to determine the applicable lighting subcategory.

The following tables are extracts from AS/NZS 1158.3.1:2020 and show the various lighting subcategories and their selection criteria.

TABLE 2.1

LIGHTING SUBCATEGORIES FOR ROAD RESERVES IN LOCAL AREAS

1	2	3	4	5	6
Type of road or pathway		Selection criteria[a,b]			Applicable lighting subcategory[c,d]
General description	Basic operating characteristics	Pedestrian/ cycle activity	Fear of crime	Need to enhance amenity	
Collector roads or non-arterial roads which collect and distribute traffic in an area, as well as serving abutting properties	Mixed vehicle and pedestrian traffic	N/A	High	N/A	PR1
		High	Medium	High	PR2
		Medium	Low	Medium	PR3[f] or PR4[f]
		Low	Low	Low	PR5
Local roads or streets used primarily for access to abutting properties, including residential, commercial and industrial precincts		N/A	High	N/A	PR1
		High	Medium	High	PR2
		Medium	Low	Medium	PR3[f] or PR4[f]
		Low	Low	Low	PR5
		N/A	N/A	N/A	PR6[e]
Common area, forecourts of cluster housing		N/A	High	N/A	PR1
		High	Medium	High	PR2
		Medium	Low	Medium	PR3[f] or PR4[f]
		Low	Low	Low	PR5

Figure 20: AS/NZS 1158.3.1:2020 Table 2.1 Selection Criteria for Road Reserves in Local Areas

TABLE 2.2

LIGHTING SUBCATEGORIES FOR PEDESTRIAN AND CYCLIST PATHS

1	2	3	4	5
Type of pathway		Selection criteria[a,b,c]		Applicable lighting subcategory
General description	Basic operating characteristics	Pedestrian/ cycle activity	Fear of crime	
Pedestrian or cycle orientated pathway, e.g. footpaths, including those along local roads[d] and arterial roads[e], walkways, lanes, park paths, cyclist paths	Pedestrian and or cycle traffic only	N/A	High	PP1[e]
		High	Medium	PP2[e]
		Medium	Medium	PP3
		Medium	Low	PP4
		Low	Low	PP5

Figure 21: AS/NZS 1158.3.1:2020 Table 2.2 Selection Criteria for Pedestrian and Cyclist Paths

TABLE 2.5

LIGHTING SUBCATEGORIES FOR OUTDOOR CAR PARKS (INCLUDING ROOF-TOP CAR PARKS)

1	2	3	4
Type of area	Selection criteria[a,c]		
	Night time vehicle and/or pedestrian movements	Fear of crime	Applicable lighting subcategory[b]
Parking spaces, aisles and circulation roadways	High	High	PC1
	Medium	Medium	PC2
	Low	Low	PC3
Designated parking spaces specifically intended for people with disabilities	N/A	N/A	PCD
For any designated areas for pedestrians to cross	N/A	N/A	PCX

Figure 22: AS/NZS 1158.3.1:2020 Table 2.5 Selection Criteria for Outdoor & Roof-top Car Parks

TABLE 3.10

LIMITATION OF UPWARD WASTE LIGHT

Luminaire application	Maximum *UWLR* Light source type	
	Non-SSL	SSL
Local roads (PR and PP and PC subcategories)	4%	1%
Public spaces (PA and PE subcategories)	5%	3%

Figure 23: AS 1159 2020 Table 3.10 Parameters for Limitation of Upward Waste Light

3.3.3 RECOMMENDED DESIGN REQUIREMENTS FOR KINGSWOOD COMMUTER CAR PARK

Based on Penrith City Council – Public Domain Lighting Policy – PDAS 003, Figure 2.1 of AS/NZS 1158.3.1:2020, AS/NZS 1680.2.1:2008and the site visit dated 21 April 2022, it is recommended that the lighting design for Kingswood Commuter Car Park complies with the following lighting design categories and associated technical parameters as a minimum.

— Roads in local areas – PR3 (PDAS 003: P3, equivalent to new PR3 lighting subcategory)

— Pedestrian pathways – PP3

— Outdoor roof top car park – PC1 (to match existing)

— Indoor car park – as per light levels nominated in AS/NZS 1680.2.1:2008

Note, the above lighting levels are the minimum requirements. It is the responsibility of the lighting designer to confirm the appropriate lighting categories and technical parameters, while considering safety and security with Penrith Council, ands as outlined in PDAS 003.

4 LIGHTING STRATEGIES

4.1 RECOMMENDED DESIGN STRATEGIES

The intent of this section is to provide lighting strategies to ensure a high-quality lit environment while minimising obtrusive light at night. The lighting design approach should consider the following:

— Provide sufficient lighting levels to enhance a sense of safety and reduce the fear of crime while avoiding a blanket lighting approach or over-lighting

— Provide a lighting ambience which is in harmony with Kingswood Station, and adjacent residential and commercial properties

— Develop the lighting design to facilitate orientation and wayfinding in the precinct

— Adopt high quality lighting technology and lighting techniques identified in this report to limit the spill of light

— Conceal or shield light sources wherever possible, to prevent direct views

— Limit the upward waste light ratio (UWLR) to less than 2%

— Use luminaires with appropriate optics to provide light coverage where needed, minimising spill light and allowing the efficient spacing of luminaires

— If decorative lighting is employed, avoid strategies such as luminous façade lighting, use subtle lighting effects

— Consider lower pole heights where appropriate to limit spread of light and minimise visibility of light source from a distance

— Light fixtures are to be high quality, consider the light colour temperature, colour rendering and distribution

— Consider the use of warm colour temperature lights (3000K) to limit the exposure to blue light at night

— The lighting design should consider whole-of-life sustainability, including longevity, modularity for replacements, optical efficiency and total energy use

— Use of luminaires and lighting equipment that are easily maintainable

4.2 RECOMMENDED LUMINAIRE TYPES

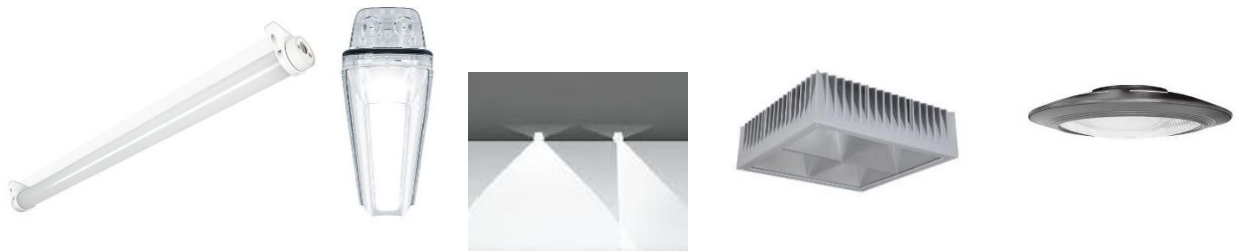
An indicative range of luminaire styles is presented below to guide good-practice design.

CAR PARK LIGHTS & ROOF-TOP LIGHTS UNDER CANOPIES

The architectural concept design for the multi-storey car park building consists of a mesh façade designed to appear to be an open translucent glowing structure at night. Therefore, controlled optics for car park lighting are essential to limit spill light.

— Consider the use of lights with controlled optics (wide, medium, narrow, asymmetric beam/adjustable)

— Locate lights away from the perimeter of the car park, or use appropriate light distribution to minimise spill light



ROOF-TOP POLE-TOP LIGHTS

— Prioritise the use of luminaires with upward waste light ratios (UWLR) less than 2%, preferably UWLR of 0%.

— Use luminaires with appropriate optics to provide light coverage where needed, minimising spill light where not needed, and allowing efficient spacing of luminaires

— Consider lower pole heights where appropriate to limit spread of light and minimise visibility of light source from a distance

— Locate the pole top luminaires on the perimeter of the rooftop, facing inwards

POLE-TOPS FOR STREET LIGHTING

— Prioritise the use of luminaires with upward waste light ratios (UWLR) less than 2%, preferably UWLR of 0%.

— Use Endeavour Energy/Penrith City Council approved lights and mounting heights

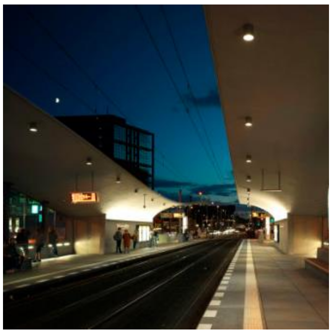
— Use luminaires with appropriate optics to provide light coverage where needed, minimising spill light where not needed, and allowing efficient spacing of luminaires

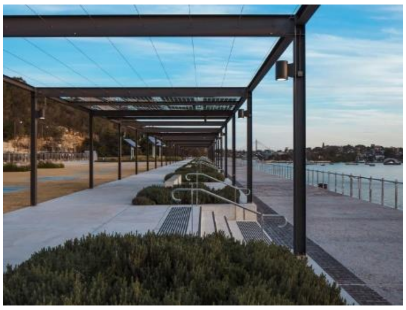
BUILDING CANOPY LIGHTS

— Consider the use of lights with controlled optics (flat beam/elliptical distribution)

— Prioritise the use of luminaires with upward waste light ratios (UWLR) less than 2%, preferably UWLR of 0%.





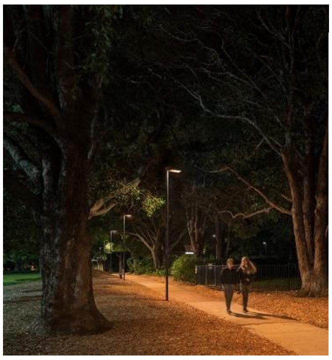


PATHWAY/LANDSCAPE LIGHTING

— Use Endeavour Energy/Penrith City Council approved lights and mounting heights if lights are to be council owned, and Endeavour Energy maintained

— Use luminaires with appropriate optics to provide light coverage where needed, minimising spill light where not needed, and allowing efficient spacing of luminaires

— Consider lower pole heights where appropriate to limit spread of light and minimise visibility of light source from a distance, as well as ensure light spread is below canopy height


4.3 RECOMMENDED LIGHTING CONTROL STRATEGIES

An effective tool in limiting obtrusive lighting is the use of appropriate lighting controls. Lighting control technologies are rapidly advancing, and LED light sources allow greater flexibility in terms of dimming and switching. Smart technologies and sensors can be incorporated in a lighting installation to provide a high degree of control. A selection of lighting control strategies to be considered includes:

- Step dimming, whereby the car park lighting runs at full brightness in peak times, and dims to a lower level late at night
- Curfew switch-off of selected lighting applications. This can be appropriate for 'decorative' lighting, which is not required for safety or orientation, and can be turned off late at night when it is less likely to add value
- Motion-detector control – luminaires incorporate motion sensors, lighting increases to maximum output when movement is detected, reverts to set minimum level when no movement is detected

4.4 OTHER RECOMMENDATIONS

There are some residential windows located on 80 Park Avenue facing towards the car park. Whilst most of these windows are some distance away from the property boundary, the effects of car headlights may be experienced as obtrusive to the residents. Headlights are not part of the Obtrusive Lighting standards, because the effects of these are not quantifiable due to different brands and types of headlights, different aiming angles, and cars being moving objects. The effects of headlights in this application are expected to be minimal because the car spaces are oriented such, that only whilst driving down the aisles, headlights are facing towards the residences. However, to further reduce the effects of headlights, the following options can be considered:

- Apply denser mesh panels at the end of the aisles
- Introduce planting at the end of the aisles
- Introduce planting of dense canopy trees in the verge next to the car park building

The rooftop car park will be exposed to the environment. Reflected light of the car park surface will spill into the night sky. AS/NZS 4282:2019 recommended limits for vertical illuminance are considering direct illuminance only, not taking reflected light into account. To reduce the reflected illuminance into the night sky, consider the use of low reflectance finishes for the rooftop surface.

5 CONCLUSION

An assessment of the existing lighting has been conducted and recommendations are provided to limit the obtrusive lighting effects of the proposed development at Kingswood car park.

The proposed design for the Kingswood car park is for a translucent structure with semi-transparent screening. The interior lighting will be integrated within the architecture avoiding direct views of the light sources and minimising light spill. Obtrusive lighting will be limited through the appropriate application of Australian Standards, the selection of light fixtures and coordination with the architectural design.

The proposed exterior lighting for the associated pathways, landscaping, and streets directly surrounding the car park and the roof top lighting shall be designed to appropriate light levels per Australian Standard and Penrith City Council requirements.

The proposed lighting for the commuter car park, associated pathways and landscaping, and streets directly surrounding the car park is expected to have a limited impact on the surrounding environment subject to the recommendations in this report being applied in the lighting design.

Appendix G

Noise and vibration assessment

Design for a better *future* /

Penrith City Council

Kingswood Commuter Car Park

Noise and Vibration Assessment

JULY 2022

CONFIDENTIAL

Question today
Imagine tomorrow
Create for the future

Kingswood Commuter Car Park
Noise and Vibration Assessment

Penrith City Council

WSP
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Approved by:	R Warren	11/07/2022	

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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Glossary

Term	Meaning
Concept design	The concept design is the preliminary design presented in this REF, which would be refined by the Contractor (should the Proposal proceed) to a design suitable for construction (subject to Transport for NSW acceptance).
Detailed design	Detailed design broadly refers to the process that the Contractor undertakes (should the Proposal proceed) to refine the concept design to a design suitable for construction (subject to Transport for NSW acceptance).
Feasible	A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.
Noise sensitive receiver	In addition to residential dwellings, noise sensitive receivers include, but are not limited to, hotels, entertainment venues, pre-schools and day care facilities, educational institutions (e.g. schools, TAFE colleges), health care facilities (e.g. nursing homes, hospitals), recording studios and places of worship/religious facilities (e.g. churches).
Out of hours work	Defined as work *outside* standard construction hours (i.e. outside of 7am to 6pm Monday to Friday, 8am to 1pm Saturday and no work on Sundays/public holidays).
Reasonable	Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.
Sensitive receivers	Land uses which are sensitive to potential noise, air and visual impacts, such as residential dwellings, schools and hospitals.
The Proposal	The construction and operation of the Kingswood Commuter Car Park.

Abbreviations

Term	Meaning
AWS	Automated Weather Station
CCTV	Closed Circuit Television
CEMP	Construction Environmental Management Plan
CNVMP	Construction Noise and Vibration Management Plan
CNVS	Construction Noise and Vibration Strategy
DECC	Department of Environment and Climate Change
DEC	Department of Environment and Conservation
EPA	Environment Protection Authority
HNA	Highly Noise Affected
ICNG	*Interim Construction Noise Guideline* (Department of Environment and Climate Change, 2000).
LGA	Local Government Area
NCA	Noise Catchment Area
NML	Noise Management Level
NSW	New South Wales
OOHW	Out of hours work
RBL	Rating Background Level
SH	Standard Hours
SPW	Sound Power Level
TfNSW	Transport for New South Wales
TMP	Traffic Management Plan

Executive Summary

WSP Australia Pty Ltd (WSP) has been engaged by Penrith City Council to undertake a noise and vibration impact assessment for the proposed Kingswood Commuter Car Park ('the Proposal'). The assessment was conducted in accordance with the *Noise Policy for Industry* (NPfI), *Interim Construction Noise Guideline* (ICNG), *Road Noise Policy* (RNP) and other relevant standards and guidelines.

Sensitive receivers surrounding the Proposal were identified during site inspections and included residential, commercial, a cemetery and educational receivers.

Background noise levels surrounding the Proposal were determined using attended and unattended noise surveys. These background noise levels were used to derive the project specific noise criteria for residential and non-residential receivers.

To assess the potential noise impacts during construction, eight representative construction scenarios were developed based on indicative staging information. Precise construction methodology would be confirmed by the construction contractor, however potential noise impacts associated with an indicative construction staging has been conservatively assessed to facilitate community consultation and effective noise management and mitigation prioritisation.

The assessment of construction noise impacts indicates that worst case noise levels are predicted to exceed relevant NMLs at the nearest sensitive receivers in NCA01 and NCA02 during all activities. The closest residences to the construction works are predicted to be highly noise affected when works occur at the closest distance to the sensitive receivers. However, it is noted that the actual noise levels would be much lower as not all plant and equipment would be operating simultaneously at the closest distance to each receiver. As a result of the predicted exceedances mitigation measures have been recommended in this report.

Any night time works are likely to generate sleep disturbance impacts at residential receivers adjacent to the Proposal. The potential for sleep disturbance has been identified in this report, and noise management and mitigation measures would be required to manage any OOHW works.

Proposal-related construction traffic noise impacts are expected to comply with the daytime road traffic criteria, however impacts will be noticeable on local roads during night time periods. It is recommended that heavy vehicle movements to and from the site be restricted to standard hours where feasible. Mitigation and management measures are presented in this report.

This report identified that there may be instances where the vibratory roller may be used within the human response minimum working distance. Relevant mitigation and management measures have been outlined to reduce the potential impacts from construction vibration associated with the Proposal.

The predicted operational noise levels were found to comply with the operational noise criteria. Management measures have been recommended in this report to ensure the noise impacts associated with the operation of the Proposal are minimised as a matter of best practice.

The road traffic assessment predicted that the construction and operational traffic associated with the Proposal were found to comply with the daytime criteria. Heavy vehicle movements during the night time period are predicted to result in exceedances of the night time criteria. Therefore, construction heavy vehicle movements should be limited to standard construction hours, where reasonable and feasible.

1 Introduction

Penrith City Council recognises the critical role commuter car parking plays in improving the quality of access to public transport for customers, particularly in the middle and outer metropolitan areas. Improving public transport for commuters is the focus of NSW Government transport initiatives. Commuter car parks are the gateways to the transport system and play a critical role in shaping customer experience of public transport, making it safe, easy and reliable.

The proposed Kingswood Commuter Car Park ('the Proposal') involves the construction of a 14 metre high multi-storey car park adjacent to the Kingswood Station. The multi-storey car park would provide a minimum of 410 commuter car parking spaces and integrate into the existing road and pedestrian network.

1.1 Proposal Description

1.1.1 Location

The Proposal is located at 6 Cox Avenue, Kingswood on the corner of Cox Avenue and Richmond Road in the Penrith City Council Local Government Area (the Proposal site). The new multi-storey car park would occupy the existing at-grade Council car park on Lot 1 DP 198211 which has 114 car parking spaces.

The proposal site is situated directly north of the Kingswood Station approximately 49 kilometres west of the Sydney Central Business District.

Figure 1-1 Location of Proposal

1.1.2 Key Features

The key features of the Proposal are:

- Removal of the existing at-grade Council car park
- Construction of a multi-storey commuter car park comprising five levels with
  - A minimum of 410 new car parking spaces
  - Approximately four accessible parking spaces on the lower ground floor and ground floor
  - Approximately seven motor bike parking spaces on the lower ground floor
  - Provision of bicycle storage on the lower ground floor
  - Provision for electric vehicle charging stations
  - Solar panels on the rooftop
- Three vehicular access and egress points on Cox Avenue, Richmond Road and through the Transport for NSW at-grade car park
- Construction of a new shared access road to the Transport of NSW at-grade car park off Richmond Road
- Ancillary works including services diversion and/or relocation, drainage works, landscaping, installation of lighting, installation of handrails and balustrades and new infrastructure (including wayfinding signage and CCTV cameras).

1.1.3 Construction

Subject to approval, construction is expected to commence in quarter two of 2023 and take around 12 months to complete.

The works required for the Proposal would be undertaken during standard NSW Environment Protection Authority (EPA) construction hours, which are as follows:

- 7.00 am to 6.00 pm Monday to Friday
- 8.00 am to 1.00 pm Saturdays
- No work on Sundays or public holidays.

Out of hours works is not anticipated, but should it be required to minimise disruptions to commuters, pedestrians, motorists and nearby sensitive receivers, approval from Council would be sought and the affected community would be notified.

Construction of the proposal would require:

- Site establishment and enabling works
- Demolition and site clearing works
- Earthworks including excavation and grading
- Building and structural works
- Installation of architectural features
- Landscaping and ancillary infrastructure
- Testing and commissioning
- Decommissioning of temporary facilities and site demobilisation.

The construction methodology would be further developed during the detailed design of the proposal by the nominated contractor in consultation with Penrith City Council.

1.2 Scope of Assessment

The purpose of this assessment is to outline the potential noise and vibration impacts associated with accessibility upgrades at Kingswood Station.

The objectives of this study are to:

- Establish noise and vibration criteria at the nearest potentially affected sensitive receivers
- Identify acoustically significant plant required for the construction works and site operations and to predict noise levels at the nearest sensitive receivers
- From results of the noise predictions, assess construction and operational noise levels against relevant criteria
- Assess potential vibration impact from construction activities
- Recommend impact mitigation and management, where necessary.

1.3 Sensitive Receivers

The Proposal has the potential to adversely impact nearby receivers that are considered sensitive to noise and vibration.

Identified sensitive receiver types surrounding the Proposal were identified via review of aerial imagery and site inspection as follows:

- Residential receivers located directly east of the Proposal site
- Non-residential receivers, including commercial premises, cemetery, and educational receivers
- Places of worship including St Joseph's Catholic Church (12 Richmond Road, Kingswood) and Kingdom Connection Ministry (16 Cox Avenue, Kingswood) were identified, however these receivers are located further away from the Proposal site and therefore the receivers identified above are more sensitive for the purpose of this assessment.

It is noted that cemeteries are not specifically identified as sensitive receivers in relevant NSW noise policies. For the purpose of this assessment, the cemetery has been considered as passive recreation.

Receivers have been categorised geographically into Noise Catchment Areas (NCAs) based on similar noise environments within these areas, to assist with assessment, consultation and notification. Receivers are assessed in terms of their land use types as these are assigned differing noise and vibration criteria.

The NCAs are described and minimum distances to nearby sensitive receivers outlined in Table 1.1. Figure 1-2 outlines the location of the Proposal, NCAs, noise monitoring locations and nearest representative noise sensitive receivers.

Table 1.1 Noise catchment areas and classification of representative receivers

NCA	RECEIVER ID	ADDRESS	RECEIVER TYPE	MINIMUM DISTANCE TO PROPOSAL [1]
1	R1	8 Cox Avenue, Kingswood	Commercial	5 m west of site
1	R2	27 Cox Avenue, Kingswood (Penrith Cemetery)	Passive Recreation	25 m north of site
1	R3	115 Joseph Street, Kingswood	Residential	180 m north of site
1	R4	12 Richmond Road Kingswood (St Joseph's Primary School)	Educational	90 m north east of site
1	R5	75 Park Avenue, Kingswood	Residential	35 m east of site

NCA	RECEIVER ID	ADDRESS	RECEIVER TYPE	MINIMUM DISTANCE TO PROPOSAL [1]
2	R6	180 Great Western Highway, Kingswood	Commercial	90 m south of site
2	R7	6 Rodgers Street, Kingswood	Residential	210 m south of site

(1) Minimum distance of the sensitive receiver buildings to the limits of the construction footprint.

1.3.1 Heritage Receivers

A search on the NSW State Heritage Inventory found one heritage item listed by Local and State Government Agencies within the Kingswood area. This is the Penrith General Cemetery, which is located on Copeland Street Kingswood, approximately 25 metres north of the proposal site.

Figure 1-2 Proposal location and nearby sensitive receivers

1.4 Relevant Guidelines

This report has been written with reference to the following documents:

- TfNSW *Construction Noise and Vibration Strategy DMS-ST-157 2019 (*including the *Construction Noise and Vibration Strategy Addendum – Replacing Tables 8 & 9, November 2019)* (CNVS)
- NSW EPA *Noise Policy for Industry 2017* (NPfI)
- NSW DECC *Interim Construction Noise Guideline 2009* (ICNG)
- NSW EPA *Road Noise Policy 2011* (RNP)
- NSW DEC *Assessing Vibration: a technical guideline 2006* (AVTG).
- Penrith City Council's *Development Control Plan 2014* (DCP)

Furthermore, the following Standards are referenced in this report:

- Australian Standard *AS 1055:2018 - Acoustics – Description and Measurement of Environmental Noise*
- British Standard *BS 7385-2-1993: Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration*
- Australian Standard *AS 2436:2010 - Guide to noise and vibration control on construction, demolition and maintenance sites*
- Department for Environment Food and Rural Affairs (DEFRA) (United Kingdom), *Update of noise database for prediction of noise on construction and open sites – Phase 3: Noise measurement data for construction plant used on quarries*
- *International Standard ISO9613-2: Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*
- German Standard *DIN 4150: Part 3 – 2016 Structural Vibration in Buildings: Effects on Structures.*

2 Existing Environment

Background and ambient noise levels surrounding the Proposal were determined through a combination of unattended and operator attended noise surveys in accordance with the AS 1055 and the NPfI.

2.1 Noise Monitoring Locations

Background noise monitoring locations were selected to be representative of the sensitive receivers with the potential to be impacted by noise from construction works. Monitoring locations were selected considering background noise influence, extraneous noise sources and logger security. Two noise monitoring locations were used to characterise the existing noise environment at representative residential receivers. The noise monitoring locations were allocated to NCAs as presented in Table 2.1 and Figure 1-2.

Table 2.1 Noise monitoring locations

NOISE MONITORING LOCATION	NCA ID	SURVEY METHOD	ADDRESS	DATES
NM01	NCA01	Unattended measurement	27 Cox Avenue, Kingswood	28th April to 6th May 2022
NM02	NCA02	Unattended measurement	4 Rodgers Street, Kingswood	28th April to 6th May 2022
ST01	NCA01	Attended measurement	8-10 Richmond Road, Kingswood	6th May 2022

2.2 Noise Monitoring Methodology

Unattended noise monitoring was conducted between Thursday 28th April and 6th May 2022 at NM01 and NM02. Each noise logger was set to record the L_{A1}, L_{A10}, L_{A90} and L_{Aeq} levels of ambient noise (L_{A1}, L_{A10}, L_{A90} are the noise levels for 1%, 10% and 90% of the sample time respectively).

Operator attended monitoring of ambient noise levels was undertaken at 75 Park Avenue, Kingswood during the daytime on 6th May 2022. The attended measurement was undertaken during periods of no rain and where the wind speed was less than five metres per second. Attended measurements were completed to qualify noise influences and identify their contribution of the various noise sources to the existing noise environment.

2.3 Instrumentation and Quality Control

The monitoring equipment was fitted with windshields and were field calibrated before and after monitoring.
No significant drifts in calibration (± 0.5 dB) were noted. The weather conditions at the time of monitoring were recorded at Penrith Lakes AWS (Bureau of Meteorology station number 067113), which is located around six kilometres north west of the Proposal.

Monitoring data was excluded for periods of weather where wind speeds were greater than five metres per second or during rainfall that may have adversely affected the collected data.

All monitoring equipment has a current certified calibration certificate (National Association of Testing Authorities, NATA) at the time of use. Details of the equipment used to conduct the noise survey are presented in Table 2.2.

Table 2.2 Noise monitoring equipment

LOCATION	SURVEY METHOD	MANUFACTURER AND MODEL NO.	SERIAL NO.
NM01	Unattended measurement	EL-316	1795-225-420
NM02	Unattended measurement	Ngara	878099
ST01	Attended measurement	Norsonic Nor140	1406502
All measurements	Attended measurement & unattended measurement	NC 75 (calibrator)	35213732

2.4 Unattended Noise Survey

A summary of the results of the unattended noise monitoring is summarised in Table 2.3. The Rating Background Level (RBL) is the overall single figure background level representing each day, evening and night time period. The results of the survey are presented graphically in Appendix A.

Table 2.3 Summary of unattended noise monitoring results

LOCATION	RATING BACKGROUND LEVEL (RBL) dBA[1]			AMBIENT NOISE LEVELS dBA L_{eq}[2]		
	Day[3]	Evening[3]	Night[3]	Day[3]	Evening[3]	Night[3]
NM01	45	45	38	58	54	52
NM02	44	45	40	56	53	49

(1) Rating Background Level (RBL), the 10th percentile min L_{A90} noise level recorded over all day, evening and night time monitoring periods

(2) Ambient noise levels: the overall noise level over each assessment period (daytime/evening/night time) as defined in the NPfI and ICNG

(3) Time periods defined as – Day: 7.00 am to 6.00 pm Monday to Saturday, 8am to 6pm Sunday; Evening: 6.00 pm to 10.00 pm; Night: 10.00 pm to 7.00 am Monday to Saturday, 10.00 pm to 8.00 am Sunday.

As part of the traffic noise assessment (see Section 4.3 and Section 7), the existing traffic noise levels along Richmond Road are required. The measured traffic noise levels at NM01 have been used to quantify the existing traffic noise levels along Richmond Road and are presented in the Table 2.4 .

Table 2.4 Measured traffic noise levels

MEASUREMENT LOCATION	PERIOD	dBA $L_{eq,1hour}$[1]
NM01	Day (7.00 am to 10.00 pm)	60
	Night (10.00 pm to 7.00 am)	55

(1) 2.5 dB correction added to represent at façade noise level

2.5 Operator Attended Noise Survey

Attended noise monitoring was undertaken directly in front of 8-10 Richmond Road, Kingswood (as shown in Figure 1-2) to identify existing noise sources within the area. The results of the attended noise survey are detailed in Table 2.5. During the surveys, the weather was noted as being fine and suitable for noise monitoring. Ambient noise levels were controlled by car pass-bys and train noise.

Table 2.5 Summary of attended noise measurement results

LOCATION	TIME	dBA $L_{eq,15min}$	dBA $L_{90,15min}$	OBSERVATIONS
ST01	4:30pm – 4:45pm	68	53	**Ambient:** Car pass-bys between 65 to 72 dBA, train pass-bys approximately 56 dBA and train horn 68 dBA **Background:** Distant traffic noise

The results of the attended noise survey are consistent with the results of the unattended monitoring (see Appendix A).

3 Assessment Criteria

3.1 Construction Noise

Chapter C12 of Penrith City Council's DCP stipulates the acoustic requirements for proposed developments. The DCP does not stipulate specific noise criteria for construction noise but references the ICNG. Hence, the ICNG has been adopted for the purpose of assessing construction noise.

The ICNG has been developed to aid the identification and understanding the impact of construction noise on sensitive land uses, and the application of reasonable and feasible management measures to minimise construction noise impacts. Given the duration of the construction (approximately 12 months), a quantitative assessment has been undertaken in accordance with the ICNG.

Given that out of hours works may be required in some cases, guidance has been taken from the TfNSW's CNVS to determine construction noise assessment periods and additional mitigation measures for out of hours works. This is consistent with the method applied in similar recent commuter car park assessments.

3.1.1 Construction Noise Assessment Periods

Table 3.1 outlines the CNVS assessment periods applicable to the Proposal.

Table 3.1 CNVS assessment periods

NAME	RBL PERIOD	TIME PERIODS
Standard Hours (SH)	Day	Monday to Friday - 7.00 am to 6.00 pm Saturday - 8.00 am to 1.00 pm Sunday/Public Holiday - Nil
Out of Hours Works (OOHW) Period 1	Day	Saturday - 7.00 am to 8.00 am and 1.00 pm to 6.00 pm Sunday and public holidays - 8.00 am to 6.00 pm
	Evening	Monday to Saturday - 6.00 pm to 10.00 pm
Out of Hours Works (OOHW) Period 2	Day	Sunday and public holidays - 7.00 am to 8.00 am
	Evening	Sunday and public holidays - 6.00 pm to 10.00 pm
	Night	All days 10.00 pm to 7.00 am

3.1.2 Construction Noise Management Levels

The ICNG provides the methodology by which noise and vibration from construction projects can be assessed and mitigation measures identified and applied. The strategy specifies that construction Noise Management Levels (NML) are to be defined using the method specified in the ICNG. This requires the development of NML based on existing RBLs and a comparison of predicted construction noise levels with the NML for identified work periods.

Recommended standard hours represent the times of the day when receivers are likely to be less sensitive to noise impacts. Where work is proposed outside of standard hours, justification is required and more stringent NMLs apply. For non-residential receiver types, the NMLs only apply when the receiver is being used.

Table 3.2 sets out the application of the management levels for noise at residential receivers.

Table 3.2 Application of the ICNG NMLs for residential receivers

TIME OF DAY	NML, dBA $L_{eq,15\ min}$	HOW TO APPLY
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm Saturday 8.00 am to 1.00 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured dBA $L_{eq,15\ min}$ 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 dBA	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 (consent, determining or regulatory) 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 dBA above the noise affected level, the proponent should consult with the community.

Table 3.3 presents the NMLs for each assessment period residential receivers in each NCA. The NMLs have been calculated from the measured and adopted RBLs in each NCA as shown in Table 2.3.

Table 3.3 NMLs at residential receivers

NCA	NOISE MONITORING LOCATION	RBL dBA			NML dBA $L_{eq,15min}$[1]			
		DAY	EVENING	NIGHT	SH	OOHW 1	OOHW 2	HNA[2]
NCA01	NM01	45	45	38	55	50	43	75
NCA02	NM02	44	45	40	54	50	45	75

(1) Time periods as defined in Table 3.1.

(2) HNA - Highly Noise Affected

Table 3.4 lists the NMLs that have been adopted for non-residential sensitive receivers. It is noted that the cemetery is not specifically identified as a sensitive receiver within the ICNG. For the purpose of this assessment, the noise criteria for passive recreation have been adopted for this receiver. The NMLs apply when the premises are in use during any assessment period.

Table 3.4 NMLs for non-residential sensitive receivers

RECEIVER TYPE	NMLs dBA $L_{eq,15min}$ [1]
Commercial	External noise level – 70
Educational	External noise level – 55[2]
Passive recreation	External noise level – 60

(1) Criteria apply when in use.

(2) External noise level determined by applying a 10 dB correction to the internal noise level criteria as stipulated in the ICNG

3.1.3 Site Specific Construction Noise Management Levels

The specific NMLs for construction activities at surrounding receivers are presented in Table 3.5. These NMLs have been determined from the background noise levels for residential receivers provided in Table 3.3.

NMLs have been presented for OOH work (OOHW) periods as construction works may be undertaken outside of standard hours.

Table 3.5 Site Specific NMLs

RECEIVER TYPE	NML dBA $L_{eq,15min}$ [1]			
	SH	OOHW 1	OOHW 2	HNA
Residential Receivers NCA01	55	50	43	75
Residential Receivers NCA02	54	50	45	75
Commercial	70	70	70	N/A
Educational[2]	55	N/A	N/A	N/A
PASSIVE RECREATION	60	N/A	N/A	N/A

(1) Time periods as defined in Table 3.1.

(2) Criteria apply when in use. It is assumed that most commercial and educational premises are unlikely to be operational outside standard hours.

3.1.4 Sleep Disturbance

Some of the proposed construction work may be required to take place during the night time periods (10.00 pm to 7.00 am), which has the potential to lower sleep quality of the residents adjacent to the work due to maximum noise level events. Potential impacts include sleep disturbance and sleep awakening reactions.

Section 4.3 of the ICNG discusses the method for quantifying and assessing sleep disturbance (sleep awakening). This guidance references the RNP that discusses criteria for the assessment of sleep disturbance.

The RNP suggests a screening level of $L_{1,1min}$ dBA, equivalent to the RBL + 15 dB. Where this level is exceeded, further analysis should be carried out. Section 5.4 of the RNP also states that:

– Maximum internal noise levels below 50 to 55 dBA would be unlikely to result in people's sleep being disturbed

– If the noise exceeds 65 to 70 dBA once or twice each night, the disturbance would be unlikely to have any notable health or wellbeing effects.

The guidance within the RNP indicates that internal noise levels of 50 to 55 dBA are unlikely to cause sleep awakening reactions. Therefore, at levels above 55 dBA, sleep disturbance would be considered likely. Assuming that receivers may have windows partially open for ventilation, a 10 dB outside to inside correction has been adopted as indicated in the ICNG.

Based on the above, the noise level 65 dBA L_{max} (external) has been adopted as sleep disturbance screening criterion for assessment purposes. Feasible and reasonable safeguards should be considered where there are night time predicted exceedances above this limit.

It should be noted that this assessment method (sleep disturbance criteria based on guidance for sleep awakening) may not capture the full extent of impacts during the early and late stage of sleep (difficulty falling asleep and waking up early). However, this assessment method would provide an indication of the potential sleep disturbance when works occur in the night time period.

Based on this guidance, site specific sleep disturbance noise goals used to assess the likelihood for sleep disturbance within residences due to night time construction activity are presented in Table 3.6.

Table 3.6 Sleep disturbance NMLs at residential receivers

NCA	NOISE MONITORING LOCATION	SLEEP DISTURBANCE CRITERIA, dBA $L_{1,1min}$	
		RNP SCREENING CRITERION	RNP AWAKENING GOAL
NCA01	NM01	53	65
NCA02	NM02	55	65

3.2 Construction Vibration

Vibration associated with construction activities can result in impacts on human comfort or the damage of physical structures such as dwellings. These two impacts have different criteria, with the effects of vibration on human comfort having a lower threshold.

Importantly, cosmetic damage is regarded as minor in nature; it is readily repairable and does not affect a building's structural integrity. If there is no significant risk of cosmetic damage, then structural damage is not considered a risk.

Section 12.7 of Penrith City Council's DCP stipulates the following in regards to vibration impacts:

> *When development may have a vibration impact on neighbouring premises, a Vibration Impact Assessment is to be prepared by a suitably qualified consultant and submitted with the development application. This assessment is to be carried out with consideration of the Assessing Vibration: a technical guideline (Department of Environment and Conservation NSW, 2006) and demonstrate that there will be no impact or recommend suitable mitigation measures.*

The vibration limits quantified in the AVaTG has been adopted herein.

3.2.1 Cosmetic Building Damage and Structural Integrity

There are no vibration limits for cosmetic building damage and structural integrity in AVaTG. Therefore, the limits set out in *British Standard BS 7358-2: Evaluation and measurement for vibration in buildings guide to damage levels from ground-borne vibration* have been adopted.

A summary of the limits is provided in Table 3.7. These peak vibration limits are set so that the risk of cosmetic damage is minimal. They have been set at the lowest level above which damage has been credibly demonstrated. The limits also assume that the equipment causing the vibration is only used intermittently.

Table 3.7 BS 7385-2 Guideline vibration limits for cosmetic damage

GROUP	TYPE OF STRUCTURE	PEAK COMPONENT PARTICLE VELOCITY, mm/s [1]		
		4–15 Hz	15–40 Hz	40 Hz AND ABOVE
1	Reinforced or framed structures Industrial or heavy commercial buildings	50		
2	Un-reinforced or light framed structures Residential or light commercial buildings	15 – 20[2]	20 – 50	50

(1) Values referred to are at the base of the building, on the side of the building facing the source of vibration (where feasible).

(2) At frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.

3.2.2 Human Comfort (Amenity)

Table 3.8 presents the limits (vibration dose values) above which there is considered to be a risk that the amenity and comfort of people occupying buildings would be affected by intermittent vibration from construction works. These limits are sourced from the AVaTG and have been reproduced in Table 3.8 below.

Table 3.8 Human comfort (amenity) guideline vibration limits (intermittent work and continuous vibration)

LOCATION	ASSESSMENT PERIOD	VIBRATION DOSE VALUE, $m/s^{1.75}$		WEIGHTED RMS VALUES FOR CONTINUOUS VIBRATION ACCELERATION (m/s^2) 1-80 Hz			
		PREFERRED VALUES	MAXIMUM VALUES	PREFERRED Z-AXIS VALUES	PREFERRED X&Y - AXES VALUES	MAXIMUM Z-AXIS VALUES	MAXIMUM X&Y - AXES VALUES
Residences	Daytime	0.20	0.40	0.010	0.0071	0.020	0.014
	Night time	0.13	0.26	0.007	0.005	0.014	0.010

3.3 Operational Noise

Section 12.4 of the DCP states that developments must comply with the relevant State Government authority or agency standards and guidelines for noise and the development is not to be intrusive (as defined in the EPA's Industrial Noise Policy).

Since the Industrial Noise Policy was superseded by the NPfI in 2017, the NPfI has been adopted to assess operational noise emissions from the Proposal.

The NPfI specifies that there are two aspects of environmental noise that require assessment. The first relates to the intrusiveness of a noise source and allows for the noise under assessment to be a margin above the background, whilst the other procedure relates to the acceptability of the resulting noise, in relation to maintaining the amenity of the surrounding area. The more stringent of the amenity or intrusive criteria would define the appropriate criteria for a project. Further, consideration of sleep disturbance is required in terms of night time operations of noise sources.

3.3.1 Proposal Intrusiveness Noise Level

A noise source would be deemed to be non-intrusive if the measured $L_{Aeq,period}$ noise level of the development does not exceed the RBL by more than 5 dBA at residential receivers. The RBL is the median of the measured L_{A90} noise level during the day, evening and night periods during periods when the development is not in operation.

Based on the results of monitoring outlined in Section Table 2.3, Table 3.9 presents the Proposal intrusiveness levels.

Table 3.9 Proposal Intrusiveness Noise Level

NCA	MONITORING LOCATION	TIME PERIOD	RBL dBA	PROPOSAL INTRUSIVENESS NOISE LEVEL (RBL + 5dB) dBA $L_{eq,15min}$
NCA01	NM01	Day	45	**50**
		Evening	45	**50**
		Night	38	**43**
NCA02	NM02	Day	44	**49**
		Evening	45	**49**[1]
		Night	40	**45**

(1) In accordance with the NPfI the evening intrusiveness noise level should be no higher than the daytime project intrusiveness noise level

(2) Intrusiveness criteria apply to residential receivers only.

3.3.2 Proposal Amenity Noise Levels

To limit continuing increases in noise levels, the amenity noise level within an area from industrial noise sources should not normally exceed the recommended amenity noise levels prescribed in the NPfI. The recommended amenity noise levels represent the objective for **total** industrial noise at a receiver location, whereas the **Proposal amenity noise level** represents the objective for noise from a **single** industrial development at a receiver location, defined as the **recommended noise levels minus 5 dB** (Table 2.2 of the NPfI).

The amenity criteria have been established at the identified receivers based on the results of the unattended noise survey. The established amenity criteria applicable to the Proposal are presented in Table 3.10.

For a conservative assessment, residential receivers within NCA01 and NCA02 have been classified as a suburban noise environment.

Table 3.10 Proposal Amenity Noise Levels

TYPE OF RECEIVER	RECOMMENDED AMENITY NOISE LEVEL (ANL) dBA $L_{eq, period}$[1]	PROPOSAL AMENITY NOISE LEVEL (ANL -5dB) dBA $L_{eq, period}$[1]
Residential (Suburban) (NM01, NM02)	Day: 55 Evening: 45 Night: 40	Day: 50 Evening: 40 Night: 35
Commercial[2]	65	60
School classroom – internal[1]	35	30
Passive recreation	50	45

(1) Day: the period from 7.00 am to 6.00 pm Monday to Saturday; or 8.00 am to 6.00 pm on Sundays and public holidays; evening: the period from 6.00 pm to 10.00 pm; night: the remaining periods

(2) Amenity levels for non-residential receivers apply when the premises are in use

3.3.3 Proposal Noise Trigger Levels

In assessing the noise impact of the Proposal on residential receivers, both intrusiveness and amenity criteria must be considered. The most stringent trigger level forms the Proposal noise trigger level (PNTL).

As required in Section 2.2 of the NPfI, all Proposal noise trigger levels and limits are expressed as $L_{eq,15\ min}$, unless otherwise expressed. In accordance with the NPfI, to standardise the time periods for the intrusiveness and amenity noise levels, the following conversion between $L_{eq,\ period}$ and $L_{eq,15\ min}$ has been applied (per Section 2.2 of the NPfI):

$$\textbf{dBA } L_{eq,15\ min} = \textbf{dBA } L_{eq,\ period} + 3\ \textbf{dB}$$

A summary of the PTNLs applicable to the Proposal is presented in Table 3.11.

Table 3.11 NPfI Proposal Noise Trigger Levels (PNTL)

RECEIVER TYPE	NCA	TIME PERIOD[1,2]	NOISE LEVEL dBA $L_{eq,15min}$		
			INTRUSIVENESS	AMENITY	PTNL
Residential (Suburban)	NCA01 (NM01)	Day	50	53	**50**
		Evening	50	43	**43**
		Night	43	38	**38**
Residential (Suburban)	NCA02 (NM02)	Day	49	53	**49**
		Evening	49[3]	43	**43**
		Night	45	38	**38**
Commercial	All	When in use	-	63	**63**
School classroom – internal	All	When in use	-	33	**33**

RECEIVER TYPE	NCA	TIME PERIOD[1,2]	NOISE LEVEL dBA $L_{eq,15min}$		
			INTRUSIVENESS	AMENITY	PTNL
School classroom – external[4]	All	When in use	-	43	**43**
Passive recreation	All	When in use	-	48	**48**

(1) Time periods defined as Day: the period from 7.00 am to 6.00 pm Monday to Saturday; or 8.00 am to 6.00 pm on Sundays and public holidays; evening: the period from 6.00 pm to 10.00 pm; night: the remaining periods

(2) Trigger levels for non-residential receivers apply when the premises are in use

(3) In accordance with the NPfI the evening intrusiveness noise level should be no higher than the daytime project intrusiveness noise level

(4) External noise level determined by applying a 10 dB correction to the internal noise level criteria as stipulated in the ICNG

3.3.4 Sleep Disturbance

Due to the continual operation of the car park, the potential for sleep disturbance to residences from noise events from the premises during the night period needs to be considered. Potential impacts include sleep disturbance and sleep awakening reactions.

As outlined in the NPfI, where the development night time noise levels at a residential location exceed the following, a detailed maximum noise level event assessment should be undertaken:

- $L_{Aeq,15min}$ 40 dBA or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{AFmax} 52 dBA or the prevailing RBL plus 15 dB, whichever is the greater.

Table 3.12 summarises the operational noise sleep disturbance screening criteria for the Proposal.

Table 3.12 Sleep disturbance Proposal screening criteria (operations)

NCA	NPFI SCREENING CRITERIA	RBL BASED SCREENING CRITERIA	PROPOSAL SCREENING CRITERIA
NCA 1	40 dBA $L_{eq15min}$	*(38 + 5)*[2] 43	**43 dBA $L_{eq,15min}$**
	52 dBA L_{Fmax}	*(38 + 15)*[3] 53	**53 dBA L_{Fmax}**
NCA 2	40 dBA $L_{eq,15min}$	*(40 + 5)*[2] *45*	**45 dBA $L_{eq,15min}$**
	52 dBA L_{Fmax}	*(40 + 15)*[3] *55*	**55 dBA L_{Fmax}**

(1) Sleep disturbance criteria apply to residential receivers only

(2) RBL + 5 as outlined in the NPfI

(3) RBL + 15 as outlined in the NPfI

3.4 Construction and Operational Road Traffic Noise

The noise from additional road traffic travelling on public roads due to the construction and operation of the Proposal has potential to impact nearby residents.

The ICNG does not provide criteria for assessing the construction traffic on public roads. Instead, the ICNG stipulates that construction traffic is assessed under the *Environmental Criteria for Road Traffic Noise* (EPA 1999), which has been superseded by the RNP. Therefore, construction and operational road traffic noise associated with the Proposal has been assessed in accordance with the RNP.

The existing roads immediately surrounding the Proposal include local roads, being Cox Avenue, Richmond Road and Park Avenue. Local roads are assessed over a one hour period (typically the peak hour) within the respective day and night periods.

Table 3.13 summarises the applicable criteria for residences.

Table 3.13 Road traffic noise criteria for residential receivers on existing roads affected by additional traffic from land use developments

ROAD TYPE	ROAD TRAFFIC NOISE CRITERIA	
	DAY	NIGHT
Local roads	55 dBA $L_{eq,1hour}$	50 dBA $L_{eq,1hour}$

The RNP application notes state that '*for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dBA above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dBA of, or exceeds, the relevant day or night noise assessment criterion*.'

Therefore, if the road traffic noise levels increase by more than 2 dBA as a result of the proposed additional traffic and the criteria in Table 3.13 are exceeded, investigation of mitigation options would be required.

4 Construction Noise and Vibration Assessment

This section outlines the assessment of construction noise and vibration impacts from the Proposal.

4.1 Construction Noise Assessment

To assess the potential noise impacts during construction, scenarios comprising typical plant and equipment have been developed based on indicative staging information.

4.1.1 Construction Stages and Duration

The Proposal would be constructed in stages with the stages occurring concurrently and at different times depending on the activity. Table 4.1 presents the assessed construction scenarios based on the indicative construction methodology.

Table 4.1 Modelling scenarios

SCENARIO ID	STAGE	ACTIVITIES	INDICATIVE DURATION (TOTAL)
SC01	Site establishment and enabling work	Secure site perimeter boundary with temporary fencing Install project signage Undertake survey to identify site boundary and mark out existing services Identify and mark trees to be retained and removed with the arborist to assess root mapping of trees to be retained to confirm extent of tree protection area Establish pedestrian and traffic controls Establish site office, amenities and plant/material storage areas Establish environmental controls, such as erosion and sediment controls Temporary relocation of existing kiss and ride shelter on Richmond Road to the north of the existing location Permanent crossover and temporary road base to access Transport for NSW land to be constructed first, prior to blocking off access through the subject site Protection and diversion of utilities within the Proposal site.	1 month

SCENARIO ID	STAGE	ACTIVITIES	INDICATIVE DURATION (TOTAL)
SC02	Demolition and site clearing works	Undertake demolition of existing asphalt and existing structures (e.g. bollards, shelter) Clear site of any existing vegetation not being retained, including grubbing of all stumps of trees to be removed Demolish obsolete kerbs in existing car park Demolition of existing path Removal and salvage of bus shelter Demolish existing drainage.	1 month
SC03	Earthworks	Excavation and regrading of the site in preparation for the multi-storey car park and road network integration works Trenching for underground utility works.	3 months
SC04	Building and structural works	Prepare the site for the construction of foundations Construct piled foundations, footings and pile caps over new piles Form and pour ground flood slabs Construct levels, including stairs, walls and columns one level at a time Construct blockwork on each level Install new lifts Install electrical, hydraulic and mechanical services infrastructure	3 months
SC05	Architectural features	Install protective screens around building perimeter Install vehicle crash barriers, balustrades, new cladding Painting of car park concrete elements Marking of car park lines, direction arrows and installation of way finding signage Installation of ancillary features including fire protection, CCTV, electrical elements, and solar panels	3 months
SC06	Precinct works	Removal of the existing bike shelter Construct pavement and hardscaped area works Relocation and consolidation of Transport for NSW waste storage within multi-storey car park Installation of new wayfinding signage, as required Undertake landscaping works Install off- line rain gardens and connections to stormwater.	2 months
SC07	Testing and commissioning	Completion of activities to test and commission power supply, lifts, security, lighting.	1 month

SCENARIO ID	STAGE	ACTIVITIES	INDICATIVE DURATION (TOTAL)
SC08	Decommissioning of temporary facilities and site demobilisation	Remove temporary site facilities Removal of footpath/pedestrian management and traffic controls Removal of environmental controls Completion of site clean-up and tidying works.	1 month

Construction compounds would be established within the construction boundary to contain construction amenities and materials laydown. Figure 1-1 presents the indicative location for the construction compound.

The exact location of the compound and works areas would be finalised by the construction contractor.

4.1.2 Working Hours

Construction work is expected to take place over a period of approximately 12 months, beginning in quarter two of 2023.

Works would generally be undertaken during standard hours however certain works may need to occur outside standard hours to maintain a safe work environment or to minimise impacts to operational transport infrastructure and services. Works outside standard hours would require approval from Council and would require further assessment.

4.1.3 Noise Source Levels

The nominated equipment for the construction work scenarios and the sound power level (SWL) of each item are detailed in Table 4.2. SWLs have been sourced from the CNVS, AS 2436:2010 - *Guide to noise and vibration control on construction, demolition and maintenance sites*, and the *Department for Environment Food and Rural Affairs (United Kingdom), Update of noise database for prediction of noise on construction and open sites – Phase 3: Noise measurement data for construction plant used on quarries* (DEFRA noise database).

Table 4.2 Sound power levels

EQUIPMENT	SOUND POWER LEVEL, dBA	NO. OF EQUIPMENT PER SCENARIO							
		SC01	SC02	SC03	SC04	SC05	SC06	SC07	SC08
Chainsaw[1]	119		1						
Compactor	106				1				
Compressor	109		1		1				
Concrete pump	103				1	1			
Concrete saw[1]	123		1				1		
Concrete truck	109				1	1			
Concrete Vibrator[1]	118				1	1			
Crane	110	1			1	1			1
Elevating work platform	98				1	1			
Excavator (10 tonne)	100		1	1					
Front-end loader	111		1	1					
Forklift	111	1		1	1	1			1

EQUIPMENT	SOUND POWER LEVEL, dBA	NO. OF EQUIPMENT PER SCENARIO							
		SC01	SC02	SC03	SC04	SC05	SC06	SC07	SC08
Generator	103	1	1		1	1			
Grinders	110		1		1	1			
Hand tools	102	1	1	1	1	1	1	1	1
Jack hammers[1]	113		1						
Lighting tower	80								
Pavement laying machine	114						1		
Piling (bored)	112				1				
Semi-trailer	108	1	1		1	1			1
Trucks (medium rigid)	103	1	1	1	1	1	1		1
Vibrating roller	114			1	1		1		
Water truck	107			1	1		1		1
Welding equipment	110				1	1			
Scenario total SWL, dBA		**115**	**125**	**118**	**123**	**121**	**124**	**102**	**116**

(1) A +5 penalty has been applied for special audible characteristics as per the CNVS.

4.1.4 *Noise Modelling Methodology*

Prediction of construction noise impacts from the Proposal has been completed using CadnaA (2021 version) noise modelling software. A three-dimensional model of the Proposal was developed, including elevation contours, locations of sensitive receivers, noise-generating equipment and intervening buildings. The model considered noise sources, receivers and the effect of distance, ground topography, atmospheric attenuation and obstacles such as barriers and buildings.

The parameters used and values adopted in the noise modelling are presented in Table 4.3.

Table 4.3 Modelling parameters

PARAMETER	INPUT
Buildings	Building footprints and number of floors taken from aerial photography. Building heights and number of floors were estimated from Google Street View as follows: 3 metres per floor
Topography	Sourced from Elvis – Elevation and Depth (1 metre contour intervals)
Prediction algorithm	ISO9613-2 1996
Meteorological conditions	Default meteorological conditions were used for all assessment periods, representative of downwind propagation conditions between 1 and 5 m/s, and equivalent to a moderate temperature inversion.
Ground surface / absorption	Model assumed a ground absorption coefficient of 0.5

PARAMETER	INPUT
Sources	All equipment has been modelled as point sources and all equipment per work stage has been modelled to operate simultaneously.
Source heights	Construction plant and equipment heights are modelled 2 metres above ground
NCA impacts	NCA noise impacts assessed at the most affected representative receiver

The noise modelling is considered to be conservative as it assumes all equipment operating simultaneously. Actual measured noise levels would be expected to be lower.

4.1.5 Predicted Noise Levels

The predicted noise levels for each scenario are presented in Table 4.4 outlining the noise level within each NCA for each representative receiver type. The predicted noise levels are presented as a range, which represents the calculated noise levels based on the noise sources being located at the closest distance to the receiver (first number) and when the noise source is located the furthest distance to the receiver (second number). This measurement allows distinction between when the works would be close or far from the receiver. The highest noise levels were then compared with the relevant NMLs to quantify the noise impacts and assist with mitigation and management measures.

As plant with special audible characteristics, such as the concrete saws, are not expected to operate for the majority of the construction works, values have been presented as a worst case scenario (includes noise generated by plant items with special audible characteristics) and a typical scenario (does not include noise generated by plant items with special audible characteristics).

Where a predicted noise level exceeds the standard hours NMLs, the OOHW NMLs are also exceeded.

The formatting of the construction noise assessment results (Table 4.4) indicates the following:

- The orange shaded cells show exceedances of the SH period.
- The green shaded cells show exceedances of the OOHW 1 period.
- The blue shaded cells exceedances of the OOHW 2 period.
- The cells with red text show exceedances of highly noise affected NMLs.

Table 4.4 Maximum predicted construction noise levels and indicative exceedances per scenario

NCA	RECEIVER ID[4]	RECEIVER TYPE	NML, dBA $L_{eq,15min}$[1]				PREDICTED NOISE LEVEL PER SCENARIO, dBA $L_{eq,15min}$									
			SH	OOHW 1	OOHW 2	HNA	SC01	SC02		SC03	SC04	SC05	SC06		SC07	SC08
							TYPICAL[3]	WORST CASE[2]	TYPICAL[3]	TYPICAL[3]	TYPICAL[3]	TYPICAL[3]	WORST CASE[2]	TYPICAL[3]	TYPICAL[3]	TYPICAL[3]
1	R1	Commercial[5]	70	-	-	N/A	> 90 - 68	> 90 - 78	> 90 - 71	> 90 - 71	> 90 - 76	> 90 - 74	> 90 - 77	> 90 - 71	80 - 55	> 90 - 69
1	R2	Passive Recreational[5]	60	-	-	N/A	66 - 59	76 - 69	68 - 61	68 - 61	73 - 66	72 - 64	75 - 67	68 - 61	53 - 45	66 - 59
1	R3	Residential	55	50	43	75	60 - 51	70 - 61	62 - 53	62 - 54	67 - 58	66 - 57	69 - 60	62 - 53	47 - 38	60 - 52
1	R4	Educational[5]	55	-	-	N/A	66 - 44	76 - 54	68 - 46	68 - 47	73 - 52	72 - 50	75 - 53	68 - 47	53 - 31	66 - 45
1	R5	Residential	55	50	43	75	**76** - 66	**86** - **76**	**78** - 68	**78** - 68	**83** - 73	**81** - 72	**84** - 75	**78** - 68	62 - 53	**76** - 66
2	R6	Commercial[5]	70	70	70	N/A	68 - 64	78 - 74	70 - 66	71 - 66	75 - 71	74 - 70	77 - 73	70 - 66	55 - 51	69 - 64
2	R7	Residential	54	50	45	75	61 - 51	71 - 61	63 - 53	64 - 54	69 - 58	67 - 57	70 - 60	64 - 53	48 - 38	62 - 52

(1) Time periods as defined in Table 3.1, HNA – Highly noise affected

(2) Predicted noise levels include the operation of plant items with special audible characteristics (concrete saw, chainsaw)

(3) Values indicate a more typical predicted noise level where plant items with special audible characteristics are not used

(4) Receiver locations as shown in Figure 1-2

(5) Criteria apply when in use.

4.1.6 Standard Hours

Table 4.4 indicates that the predicted construction noise levels at the nearby residential receivers would typically exceed the standard hours NML throughout the construction period. The worst case exceedance at a residential receiver would be up to 31 dBA.

Furthermore, the nearest residential receiver (R4) is predicted to be highly noise affected when works occur at the closest distance to the receiver. However, it is noted that when works move further away, the receiver is generally no longer highly noise affected.

For other sensitive receivers (R1, R2, R4 and R6), the worst case construction noise levels are predicted to exceed the daytime NML for standard hours.

It is noted that a number of the scenarios incorporate plant with annoying acoustic characteristics, which have resulted in the application of a noise penalty (refer to Section 4.1.3). This includes plant such as concrete saws and chainsaws, which are expected to be used very infrequently and over short periods over the construction period. It is highly unlikely that these items of equipment would be utilised on a regular basis throughout the construction works. Where these equipment are not used, noise levels would be notably decreased in their impact to receivers. This assessment addresses the impacts of both cases, however impacts with annoying plant would be of short duration and impacts without such plant being operational are more indicative of any sustained impact over a given construction activity event.

Furthermore, noise levels presented in this assessment are conservative, with noise sources assumed to operate simultaneously. In reality noise impacts are likely to be lower as plant items would not be operating simultaneously at all times and therefore it would be likely that the predicted noise levels would be reduced for some receivers. Works are expected to take place intermittently over any construction period, so these exceedances would not be expected to occur continuously over the duration of the Proposal.

Based on the current design and construction methodology for the Proposal, noise impacts would be noticeable during standard hours at the nearest receivers to the works areas. As a result of the predicted exceedances, noise mitigation and management measures have been outlined in Section 5 to reduce potential noise impacts.

4.1.7 Outside Standard Hours

The majority of construction activities are proposed to be completed within standard construction hours, although out of hours work may be required. A high level assessment has been undertaken for out of hours work (OOHW), however it is recommended that a more detailed noise assessment should be undertaken if out of hours works is required.

Based on the predicted construction noise levels in Table 4.4, the OOHW criteria for the nearby receivers would be exceeded during the construction of the Proposal.

However, these scenarios include some plant, such as concrete saws and chainsaws, with annoying acoustic characteristics which incur a noise penalty (refer to Section 4.1.3). Concrete saws and chainsaws are expected to be used infrequently and over short periods over the construction period. It is also highly unlikely that these items of equipment would be fully utilised during works, and would not likely be used during OOHW periods. While equipment such as concrete saws and chainsaws are not in use, construction noise levels would be notably lower (refer to Section 5.2). This assessment considers the impacts of both cases, however impacts with annoying plant would be of short duration and impacts without such plant being operational are more indicative of any sustained impact over a given construction activity event.

Additionally, noise levels presented in this assessment are conservative, with noise sources assumed to operate simultaneously and in a single location. In reality, noise impacts are likely to be lower as plant items would be spatially distributed and would not be operating simultaneously at all times. Works are expected to take place intermittently over any construction period, so these exceedances would not be expected to occur continuously over the duration of the Proposal.

As a result of the predicted exceedances during OOHW, further noise mitigation and management measures would be required in the event of OOHW works being undertaken, and an overview has been outlined in Section 5 to reduce the potential noise impacts for consideration.

4.1.8 Sleep Disturbance

Out of Hours Works have the potential to generate sleep disturbance impacts. The ICNG requires a quantitative assessment for construction works that extend over two consecutive nights. The maximum noise level assessment presented in Table 4.5 provides an indication for the potential for sleep disturbance at nearby residential receivers. The predicted noise levels have been assessed for nearby residential receivers.

The formatting within the maximum noise level results (Table 4.5) indicates the following:

- The grey shaded cells show exceedances of the RNP screening criteria.
- The blue shaded cells show exceedances RNP awakening criteria.

Noise levels are predicted to result in exceedances of both the RNP screening criteria and the awakening goals. The potential for work to generate maximum noise level events should be considered as part of the construction noise management plan for the works. Additionally, mitigation measures should be implemented for out of hours work, including a more detailed noise assessment for any out of hours work (if required). Mitigation measures are discussed further in Section 5.

Table 4.5 Predicted sleep disturbance noise impacts (residences only)

NCA	RECEIVER ID[1]	NML, dBA $L_{eq,15min}$[1]		MODELLED MAXIMUM NOISE LEVEL PER SCENARIO, DBA $L_{eq,15min}$							
		RNP SCREENING CRITERION	RNP AWAKENING GOAL	SC01	SC02	SC03	SC04	SC05	SC06	SC07	SC08
1	R3	53	65	60	70	62	67	66	69	47	60
1	R5	53	65	76	86	78	83	81	84	62	76
2	R7	55	65	61	71	64	69	67	70	48	62

(1) Sleep disturbance criteria applicable to residential receivers only.

4.2 Construction Vibration Assessment

The major potential sources of vibration from the proposed construction activities are from the pile boring, jackhammering and smooth drum (vibratory) roller equipment (SC02, SC03, SC04 and SC06).

4.2.1 Safe Working Distances for Vibration Intensive Plant

Table 4.6 presents the indicative minimum working distances for the nominated construction plant to minimise the risk of structural damage and human comfort for sensitive receivers, outlined in the CNVS. The distances are based on the typical distance from receivers that work is permitted to meet the limits set out in Section 3.2.

Table 4.6 Recommended minimum working distances for vibration intensive plant

PLANT ITEM	RATING/ DESCRIPTION	MINIMUM WORKING DISTANCE		
		COSMETIC DAMAGE	HUMAN RESPONSE	HERITAGE
Piling rig - bored	≤ 800mm	2 metres (nominal)	N/A	5 metres
Vibratory roller	< 200 kN (typically 4-6 t)	12 metres	40 metres	15 metres
Jackhammer	Hand held	1 metre (nominal)	Avoid contact with structure	3 metres

The safe working distances are indicative only and results may vary depending on the activity, equipment, local geotechnical conditions. They apply to typical buildings under typical geotechnical conditions.

The construction footprint is located approximately 35 metres from nearest residential dwellings in NCA01. No activities are proposed within the cosmetic damage minimum working distances for residential receivers, therefore structural impacts are not anticipated as a result of the construction works. However, there may be instances where the vibratory roller is used within the human response minimum working distance and therefore may affect the amenity for nearby sensitive receivers (within 40 metres of the construction works). Given that there is potential for receivers to be affected by vibration intensive plant, vibration mitigation measures have been provided in Section 5. where works occur outside minimum working distances , no adverse impacts are expected for cosmetic damage or human response on nearby sensitive receivers.

No heritage items were identified within the heritage safe working distances of the footprint, therefore vibration impacts to heritage structures are not considered further in this assessment.

Where different vibration intensive equipment or different construction work areas are proposed, the vibration impacts must be reassessed.

4.3 Construction Traffic Assessment

4.3.1 Traffic Volumes and Routes

The Proposal would see construction traffic entering and exiting the site via Richmond Road, impacting on the nearest receivers on surrounding public roads.

Speed limits would be 50 km/h in this area, however due to the accessibility it is likely to be closer to 30 km/h when accessing the site, thus speeds of 30 km/h have been modelled.

It is anticipated that construction works would generate up to nine heavy vehicle movements per hour. Additionally, a maximum workforce of approximately 70 workers is predicted. As a worst case scenario, it is assumed that the nine heavy vehicle movements and the 70 light vehicle movements occur within the same hour.

4.3.2 Predicted Construction Traffic Noise

Based on the assumptions in Section 4.3.1, road traffic noise was predicted at the residential receivers along Richmond Road and presented in Table 4.7.

Table 4.7 Predicted construction traffic noise levels

RECEIVER LOCATION	DISTANCE FROM RECEIVER[1]	TIME PERIOD[2]	CRITERIA	EXISTING	PREDICTED[3]	RELATIVE INCREASE, dB	COMPLIANCE
Residences along Richmond Road	10 m	Day	55 dBA $L_{eq,1hour}$	60 dBA $L_{eq,1hour}$	58 dBA $L_{eq,1hour}$	1.9	Yes

(1) Distance from typical residential receiver to the closest carriageway

(2) Time periods as defined in the RNP: Day (7.00 am to 10.00 pm) and Night (10.00 pm to 7.00 am)

(3) Predicted noise level includes façade reflection (i.e. at façade noise level)

This assessment has demonstrated that the Proposal would generate a minor increase in traffic noise on affected roads associated with the construction activities, however levels are expected to remain within RNP daytime criteria.

During the daytime, the Proposal’s construction traffic is not expected to be significant when compared with the existing traffic noise.

Heavy vehicle movements during the night time may exceed the relevant night time RNP criteria. Therefore, it is recommended that heavy vehicle movements should be limited to the daytime, where feasible and reasonable.

As best practice, it is recommended that a Traffic Management Plan be developed for the proposal, and its findings used to inform the CNVMP.

5 Construction Noise and Vibration Mitigation and Management

5.1 Standard Construction Noise and Vibration Mitigation

Prior to commencement of works, a Construction Noise and Vibration Management Plan (CNVMP) would be prepared and implemented in accordance with the requirements of the ICNG. The CNVMP would take into consideration measures for reducing the source noise levels of construction equipment by construction planning and equipment selection where practicable.

The CNVMP would outline measures to reduce the noise impact from construction activities. Reasonable and feasible noise mitigation measures which would be considered include:

- Avoiding any unnecessary noise when carrying out manual operations and when operating plant
- Ensuring spoil is placed and not dropped into awaiting trucks
- Avoiding/limiting simultaneous operation of noisy plant in discernible range of a sensitive receiver where practicable
- Switching off any equipment not in use for extended periods e.g. heavy vehicles engines would be switched off whilst being unloaded
- Restriction of heavy vehicle movements to and from the site to standard (daytime) hours where feasible and avoiding deliveries at night/evenings wherever practicable
- No idling of delivery trucks
- Keeping truck drivers informed of designated routes, parking locations and acceptable delivery hours for the site
- Compounds, refuelling areas and work areas designed to promote one-way traffic so that vehicle reversing movements are minimised
- Minimising talking loudly; no swearing or unnecessary shouting, or loud stereos/radios onsite; no dropping of materials from height where practicable, no throwing of metal items and slamming of doors
- Maximising offset distances between noisy plant and adjacent sensitive receivers and determining safe working distances
- Using the most suitable equipment necessary for the construction works at any one time
- Directing noise-emitting plant away from sensitive receivers
- Regularly inspecting and maintaining plant to avoid increased noise levels from rattling hatches, loose fittings etc
- Using non-tonal reversing/movement alarms such as broadband (non-tonal) alarms or ambient noise-sensing alarms for all plant used regularly onsite (greater than one day), and for any out of hours works
- Use of quieter and less vibration emitting construction methods where feasible and reasonable

The most applicable standard management measures are outlined as follows:

- Construction hours and scheduling:
  - Works would generally be carried out during standard construction hours (i.e. 7.00 am to 6.00 pm Monday to Friday; 8.00 am to 1.00 pm Saturdays). Any works outside these hours may be undertaken if approved by Council and the community is notified prior to these works commencing. A detailed noise assessment should be undertaken for any out of hours activities.

- Respite periods:
  - Where the $L_{Aeq,15min}$ construction noise levels are predicted to exceed 75 dBA and/or 30 dB above the Rating Background Level at nearby affected sensitive receivers, respite periods would be observed, where practicable, and in accordance with the CNVS. This would include restricting the hours that very noisy activities can occur.
- Vibration amenity:
  - It is proposed that community consultation should be undertaken for any residents located within the human comfort minimum working distance. The community consultation may include the following:
    - Undertake a letterbox drop outlining construction methods, duration and timing of events – as a guide, any potentially affected receivers located within the human comfort minimum working distance should be notified. Notification to be provided a minimum 7 days prior to commencement of works.
    - A contact number should be provided to the public through both the letterbox drop and via a sign erected on the site boundary, so that information can be received, or complaints made in relation to vibration (or noise). A log of complaints would be maintained and actioned.

Table 5.1 provides indicative benefits of typical engineering control mitigation measures for construction activities, based on guidance in AS 2436 and experience on similar construction proposals.

Table 5.1 Indicative noise reduction from construction controls

ENGINEERING CONTROLS	POSSIBLE NOISE REDUCTION, dB
Portable temporary screens	5-10
Screen or enclosure for stationary equipment	10-15
Maximising the offset distance between noisy plant items and sensitive receivers.	3-6
Avoiding using noisy plant simultaneously and/or close together, adjacent to sensitive receivers.	2-5
Orienting equipment away from sensitive receivers.	3-5
Carrying out loading and unloading away from sensitive receivers.	3-5
Using noise source controls, such as the use of residential class mufflers, to reduce noise from all plant and equipment including bulldozers, cranes, graders, excavators and trucks	5-10
Selecting site access points and roads as far as possible away from sensitive receivers	3-6

5.2 Site Specific Construction Noise Mitigation

The following site-specific construction noise mitigation measures should be considered:

- During SC01 (site establishment), temporary barriers should be erected to ensure that work would be conducted behind temporary hoardings/screens wherever practicable. The installation of construction hoarding would take into consideration the location of sensitive receivers to ensure that 'line of sight' is broken, where feasible. This has the potential to reduce noise levels between 5 and 10 dB.
- During SC02 (demolition) to SC06 (precinct works), the concrete saw is the main contributor to construction noise. Without the concrete saw, the total activity noise level is reduced by 6-8 dB. It is recommended that the use of these plant items is limited where possible, and works are undertaken during Standard Hours and avoid sensitive time

periods. Where work is required outside of standard hours, the use of this equipment is to avoid sensitive periods such as after midnight and before 7 am.

- Due to the high exceedances of NMLs during SC02 (demolition) to SC06 (precinct works), when a concrete saw is to be used near sensitive receivers it is recommended that a temporary screen or enclosure (10-15 dB reduction) is placed around the works in conjunction with temporary barriers.
- Activities at the nearest residential receivers are likely to fluctuate over the course of the day, therefore, it is recommended that consultation be undertaken with operators to determine feasible construction staging to manage impacts, effectively communicate likely impacts, potential periods of high intensity works, and to develop a schedule of consultation to program intensive works outside the most active periods. Respite periods should be negotiated and a community consultation strategy developed to ensure a complaints hotline and feedback pathway is established.
- A traffic management plan is to be prepared to manage construction noise impacts. This should include delivery schedules, speed limits and circulation recommendations (measures to promote one-way traffic).

5.3 Additional Construction Noise Mitigation

Where all reasonable and feasible standard mitigation measures have been applied and exceedances are still predicted to occur, the CNVS provides guidance on additional mitigation measures to be implemented for each receiver depending on level of exceedance for the predicted noise level above the NML. Additional mitigation measures and their associated acronyms are outlined in Appendix B. Table 5.2 outlines when to implement the additional noise management measures.

Table 5.2 Implementation of additional management measures

CONSTRUCTION HOURS	RECEIVER PERCEPTION	dB ABOVE RBL[4]	dB ABOVE ANML	ADDITIONAL MANAGEMENT MEASURES[1]
Standard Hours Monday-Friday (7.00 am to 6.00 pm) Saturday (8.00 am to 1.00 pm)	Noticeable	5 to 10	0	-
	Clearly audible	> 10 to 20	< 10	-
	Moderately intrusive	> 20 to 30	> 10 to 20	PN, V
	Highly intrusive	> 30	> 20	PN, V
	75dBA or greater	N/A	N/A	PN, V, SN
OOHW Period 1 Monday-Friday (6.00 pm to 10.00 pm) Saturday (7.00 am to 8.00 am, 1.00 pm to 10.00 pm) Sunday/PH (8.00 am to 6.00 pm)	Noticeable	5 to 10	< 5	-
	Clearly audible	> 10 to 20	5 to 15	PN, RP[2], DR[2]
	Moderately intrusive	> 20 to 30	> 15 to 25	PN, V, SN, RO, RP[2], DR[2]
	Highly intrusive	> 30	> 25	PN, V, SN, RO, RP[2], DR[2]
OOHW Period 2	Noticeable	5 to 10	< 5	PN
	Clearly audible	> 10 to 20	5 to 15	PN, V, SN, RO[3], RP[2], DR[2]
	Moderately intrusive	> 20 to 30	> 15 to 25	PN, V, SN, RO[3], RP[2], DR[2]

CONSTRUCTION HOURS	RECEIVER PERCEPTION	dB ABOVE RBL[4]	dB ABOVE ANML	ADDITIONAL MANAGEMENT MEASURES[1]
Monday-Saturday (12.00 am to 7.00 am, 10.00 pm to 12.00 am) Sunday/PH (12.00 am to 8.00 am, 6.00 pm to 12.00 am)	Highly intrusive	> 30	> 25	PN, V, SN, RO[3], RP[2], DR[2], AA

(1) PN = Project notification, SN = Specific notification, individual briefings, or phone call, V = Verification monitoring, DR = Duration Reduction, RP = Respite Period, RO = Project specific respite offer, AA = Alternative accommodation

(2) Respite periods and duration reduction are not applicable when works are carried out during OOHW Period 1 Day only (i.e. Saturday 6am-7am and 1pm-6pm, Sundays / Public Holidays 8am-6pm)

(3) Respite offers during OOHW Period 2 are only applicable for evening periods (i.e. Sundays / Public Holidays (6pm-10pm), and may not be required if a respite offer has already been made for the immediately preceding OOHW Period 1.

(4) SWLs used for the purpose of estimating noise impact shall be increased by 5dBA where works will include power saws for the cutting of timber, masonry & steel; grinding of metal, concrete or masonry; rock/line drilling; bitumen milling & profiling; jack hammering, rock hammering & rock breaking; or impact piling as a correction factor for noise with special audible characteristics.

5.4 Additional Construction Vibration Mitigation

Where vibration intensive activities occur within the minimum working distances, all reasonable and feasible standard mitigation measures have been applied, and exceedances of vibration management levels are expected, the CNVS provides guidance on additional mitigation measures to be implemented for each receiver. Additional mitigation measures and the associated acronyms are outlined in Appendix B.

Table 5.3 outlines how to implement the additional vibration management measures.

Table 5.3 Implementation of additional vibration management measures

CONSTRUCTION HOURS	RECEIVER PERCEPTION	ABOVE VIBRATION LIMIT	ADDITIONAL MANAGEMENT MEASURES[3]
Standard hours Monday-Friday (7.00 am to 6.00 pm) Saturday (8.00 am to 1.00 pm)	Human disturbance	> HVML[1]	PN, V, RO
	Building damage	> DVML[2]	V, AC

(1) Human vibration management level – see maximum vibration dose values for human comfort outlined in Section 3.2.2

(2) Damage vibration management level – see screening criteria for cosmetic damage outlined in Section 3.2.1

(3) PN = project notification, V = verification monitoring, RO = project specific respite offer, AC = Alternative construction methodology

6 Operational Noise Assessment

6.1 Overview

The Proposal would provide 418 commuter car park spaces with access to the car park from Richmond Road and Cox Avenue.

Operational noise from the commuter car park is anticipated to be emanated from the following noise sources:

- Mechanical plant noise (e.g. rooftop lift motors)
- Internal vehicular movements, including car parking and deliveries.

The car park would operate 24 hours, 7 days a week.

Traffic noise impacts from vehicles entering and existing the car park on the public road network are assessed separately, as discussed in Section 7.

6.2 Noise Sources

6.2.1 Mechanical Plant

Indicative sound power levels for the mechanical plant and equipment servicing the car park are based on sound data used on similar commuter car park projects.

The sound power levels adopted for this assessment are presented in Table 6.1.

Table 6.1 Mechanical plant sound power levels (SWL)

SOURCE	QUANTITY	SOUND POWER LEVEL DB / FREQUENCY (HZ)								
		63	125	250	500	1k	2k	4k	8k	SWL dBA
Lift motor	2	65	63	63	63	67	67	65	61	**73**
Lift shaft fan	2	70	68	68	68	72	72	70	66	**78**
Inverter	2	16	35	39	48	54	56	56	47	**61**
Generator	1	57	67	72	70	74	75	75	71	**81**

6.2.2 Car Park Vehicle Movements

The movement of vehicles within the car park is likely to generate noise which may impact surrounding receivers. The Traffic Impact Assessment (ref: *SY210295* dated 19/05/2022) identifies that the AM and PM peak traffic volumes are to occur from 7.45 am to 8.45 am and 4.45 pm to 5.45 pm respectively. Additionally, the report predicts that the Proposal would generate 102 vehicle movements during the AM peak and PM peak.

For a worst case scenario, the AM peak vehicle movements were used in assessing the daytime period (7.00 am to 6.00 pm) and the PM peak vehicle movements were used to assess the evening periods (6.00 pm to 10.00 pm). Furthermore, it was assumed that during the night time period (10.00 pm to 7.00 am) peak vehicle movements would be approximately five vehicle movements within an hour.

Additionally, the model has assumed that all vehicles enter the car park and park within five minutes.

Noise from movement of vehicles (vehicles starting, idling and driving) has been modelled using the sound power levels in Table 6.2.

Table 6.2 Car parking noise levels – onsite car movements

SOURCE	EVENT SOUND POWER LEVEL dBA L_{eq}	MAXIMUM NOISE LEVEL dBA L_{max}
Internal Car Movement (starting, idling and driving)[1]	74	93

(1) Measured noise levels for tor unlocking, entering and starting a light vehicle, followed by acceleration.

Based on measurements undertaken for similar projects, the noise levels from vehicle movements within car parks can be up to 4 dB louder than the L_{eq} sound power level presented in Table 6.2. This can be attributed to wheel squeal or engine noise when travelling up ramps and would be dependent on the behaviour of the driver. To account for the potential for wheel squeal and increased engine noise when travelling up ramps, a 4 dB correction has been applied to the assumed car movement sound power level.

6.3 Predicted Noise Levels

Prediction of operational noise impacts from the Proposal has been completed using CadnaA noise modelling software (version 2021) using the ISO 9613-2 calculation method.

A three-dimensional model of the Proposal was developed, including elevation contours, locations of sensitive receivers, noise-generating equipment and intervening buildings. The model considered noise sources, receivers and the effect of distance, ground topography, atmospheric attenuation and obstacles such as barriers and buildings.

It is understood that no enclosed façade is proposed for the car park. The proposed design provides aesthetic screening, however as these are not continuous, no acoustic screening will occur as a result of this design. Further, it is understood that some vegetation would be incorporated between the Proposal and the nearest residence; noise screening impacts due to this vegetation will be negligible.

The shielding from each floor of the car park has been included in the model.

This report has not considered the use of polished concrete, which is installed in some car park facilities. This floor type generates substantial tyre noise and is the source of most car park noise complaints. Due to the proximity of nearby residences, it is recommended that polished concrete is not used in this facility.

Table 6.3 presents the predicted L_{Aeq} noise levels from the car park to the nearest receivers.

Table 6.3 Predicted operational noise levels

NCA	RECEIVER ID[2]	NPfI NOISE CRITERIA, dBA $L_{eq,15min}$			PREDICTED NOISE LEVELS, dBA $L_{eq,15min}$		
		Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
1	R1	63[3]	-	-	43	43	38
1	R2	48	-	-	34	34	31
1	R3	50	43	38	29	29	27
1	R4	43[3]	-	-	33	33	29
1	R5	50	43	38	40	40	38
2	R6	63[3]	63[3]	63[3]	38	38	37
2	R7	49	43	38	31	31	30

(1) Time periods defined as – Day: 7.00 am to 6.00 pm; Evening: 6.00 pm to 10.00 pm; Night: 10.00 pm to 7.00 am.

(2) Receivers identified in Figure 1-2

(3) Criteria for non-residential land uses applicable when in use

Based on Table 6.3, the predicted noise levels comply with the day, evening and night time criteria at all receivers therefore, no mitigation is required. Nonetheless, Section 6.5 provides mitigation measures to ensure that operational noise is minimised as a matter of best practice.

6.4 Maximum Noise Level Assessment

Maximum noise level events are mainly attributed to car doors closing within the car park.

The assessment of maximum noise level events has been undertaken and the results to residential receivers have been presented in Table 6.4, based on the maximum noise level SWL provided in Table 6.2.

Table 6.4 Predicted maximum noise levels (residential receivers)

NCA	RECEIVER ID[1]	SLEEP DISTURBANCE SCREENING LEVEL, dBA L_{max}	PREDICTED MAXIMUM NOISE LEVEL, dBA L_{max}
1	R3	53	37
1	R5	53	53
2	R7	55	35

(1) Receivers identified in Figure 1-2

The results in Table 6.4 indicate that maximum noise levels do not exceed the sleep disturbance screening level and therefore it is not anticipated that the proposal will cause sleep disturbance for nearby residential receivers.

6.5 Operational Mitigation and Management Measures

The operational noise was assessed based on the car park movements detailed in Section 6.2.2 and the noise data for the mechanical plant presented in Table 6.1.

In order to ensure noise levels are managed below relevant noise criteria, the following mitigation and management measures should be implemented to minimise the noise impacts at the nearby receivers:

- Polished concrete should not be used for the Proposal
- As best practice, it is recommended that the community consultation be conducted to advise the surrounding residences of the likely impacts
- It is recommended that signage and traffic calming devices should be implemented to manage the speed of vehicles throughout the car park
- Stairwell doors should utilise soft closing mechanisms
- Any speedbumps should be fully concrete or rubber where possible
- Mechanical plant selected must comply with the sound data provided in Table 6.1. Where additional/ alternative mechanical plant and equipment is proposed, the operational noise assessment must be updated by a qualified acoustic consultant
- Management measures should be implemented to deter anti-social behaviour (for example loitering in the car park during the night)
- A Traffic Management Plan should be implemented to manage offsite noise impacts.

7 Operational Road Traffic Noise Assessment

This section assesses the potential noise impacts associated with the additional road traffic generated by the Proposal travelling on public roads.

Calculations were based on the UK's Department of Environment, *Calculation of Road Traffic Noise* (CORTN).

7.1 Traffic Volumes and Routes

Vehicles travelling on public roads, generated by the Proposal, has potential to impact the nearest residential receivers. It is proposed that vehicles will enter and exit the car park via the driveways located along Richmond Road (lower ground level) and Cox Avenue (ground level). With reference to the RNP, there are no sensitive receivers along Cox Avenue, and therefore the road traffic impacts along Cox Avenue have not been considered further.

Speed limits would be 50 km/h in this area, however due to the accessibility it is likely to be closer to 30 km/h when accessing the site, thus speeds of 30 km/h have been modelled.

The Traffic Impact Assessment (ref: *SY210295* dated 19/05/2022) predicts up to 102 vehicle movements occurring during the AM and PM peak. It is noted that the AM and PM peak occur during the RNP daytime period (7.00 am to 10.00pm) and therefore only the daytime period has been assessed herein.

7.2 Predicted Construction Traffic Noise

Based on the assumptions in Section 7.1, road traffic noise was predicted at the residential receivers along Richmond Road and presented in Table 7.1.

Table 7.1 Predicted operational traffic noise levels

RECEIVER LOCATION	DISTANCE FROM RECEIVER[1]	TIME PERIOD[2]	CRITERIA	EXISTING	PREDICTED[3]	RELATIVE INCREASE, dB	COMPLIANCE
Residences along Richmond Road	10 m	Day	55 dBA $L_{eq,1hour}$	60 dBA $L_{eq,1hour}$	56 dBA $L_{eq,1hour}$	1.5	Yes

(1) Distance from typical residential receiver to the closest carriageway

(2) Time periods as defined in the RNP: Day (7.00 am to 10.00 pm) and Night (10.00 pm to 7.00 am)

(3) Predicted noise level includes façade reflection (i.e. at façade noise level)

These results indicate a minor increase in traffic noise (less than 2 dB) on local roads associated with the peak hour usage of the proposed car park.

As a result, no traffic noise management and mitigation measures would be required to manage traffic impacts to an acceptable level.

8 Conclusion

WSP has undertaken a noise and vibration assessment for the proposed Kingswood Commuter Car Park. The assessment was conducted in accordance with the *Noise Policy for Industry* (NPfI), *Interim Construction Noise Guideline* (ICNG), *Road Noise Policy* (RNP) and other relevant standards and guidelines.

Sensitive receivers surrounding the Proposal were identified during site inspections and included residential, commercial, a cemetery and educational receivers.

Background noise levels surrounding the Proposal were determined using attended and unattended noise surveys. These background noise levels were used to derive the project specific noise criteria for residential and non-residential receivers.

To assess the potential noise impacts during construction, eight representative construction scenarios were developed based on indicative staging information. Precise construction methodology would be confirmed by the construction contractor, however potential noise impacts associated with an indicative construction staging has been conservatively assessed to facilitate community consultation and effective noise management and mitigation prioritisation.

The assessment of construction noise impacts indicates that worst case noise levels are predicted to exceed relevant NMLs at the nearest sensitive receivers in NCA01 and NCA02 during all activities. The closest residences to the construction works are predicted to be highly noise affected when works occur at the closest distance to the sensitive receivers. However, it is noted that the actual noise levels would be much lower as not all plant and equipment would be operating simultaneously at the closest distance to each receiver. As a result of the predicted exceedances mitigation measures have been recommended in this report.

Any night time works are likely to generate sleep disturbance impacts at residential receivers adjacent to the Proposal. The potential for sleep disturbance has been identified in this report, and noise management and mitigation measures would be required to manage any OOHW works.

Proposal-related construction traffic noise impacts are expected to comply with the daytime road traffic criteria, however impacts will be noticeable on local roads during night time periods. It is recommended that heavy vehicle movements to and from the site be restricted to standard hours where feasible. Mitigation and management measures are presented in this report.

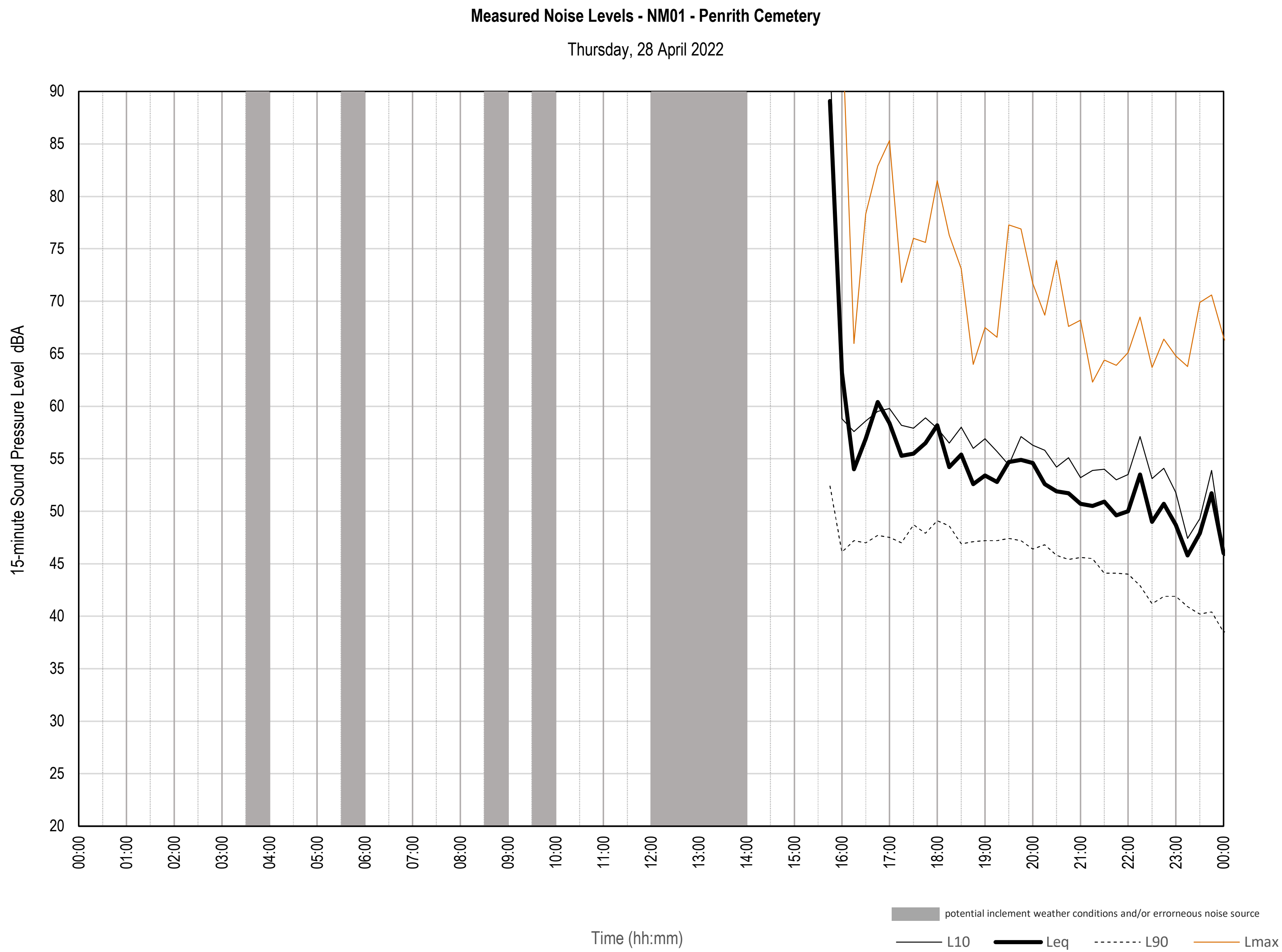
This report identified that there may be instances where the vibratory roller may be used within the human response minimum working distance. Relevant mitigation and management measures have been outlined to reduce the potential impacts from construction vibration associated with the Proposal.

The predicted operational noise levels were found to comply with the operational noise criteria. Management measures have been recommended in this report to ensure the noise impacts associated with the operation of the Proposal are minimised as a matter of best practice.

The road traffic assessment predicted that the construction and operational traffic associated with the Proposal were found to comply with the daytime criteria. Heavy vehicle movements during the night time period are predicted to result in exceedances of the night time criteria. Therefore, construction heavy vehicle movements should be limited to standard construction hours, where reasonable and feasible.

Appendix A

Noise Monitoring Graphs



Measured Noise Levels - NM01 - Penrith Cemetery
Thursday, 28 April 2022
15-minute Sound Pressure Level dBA
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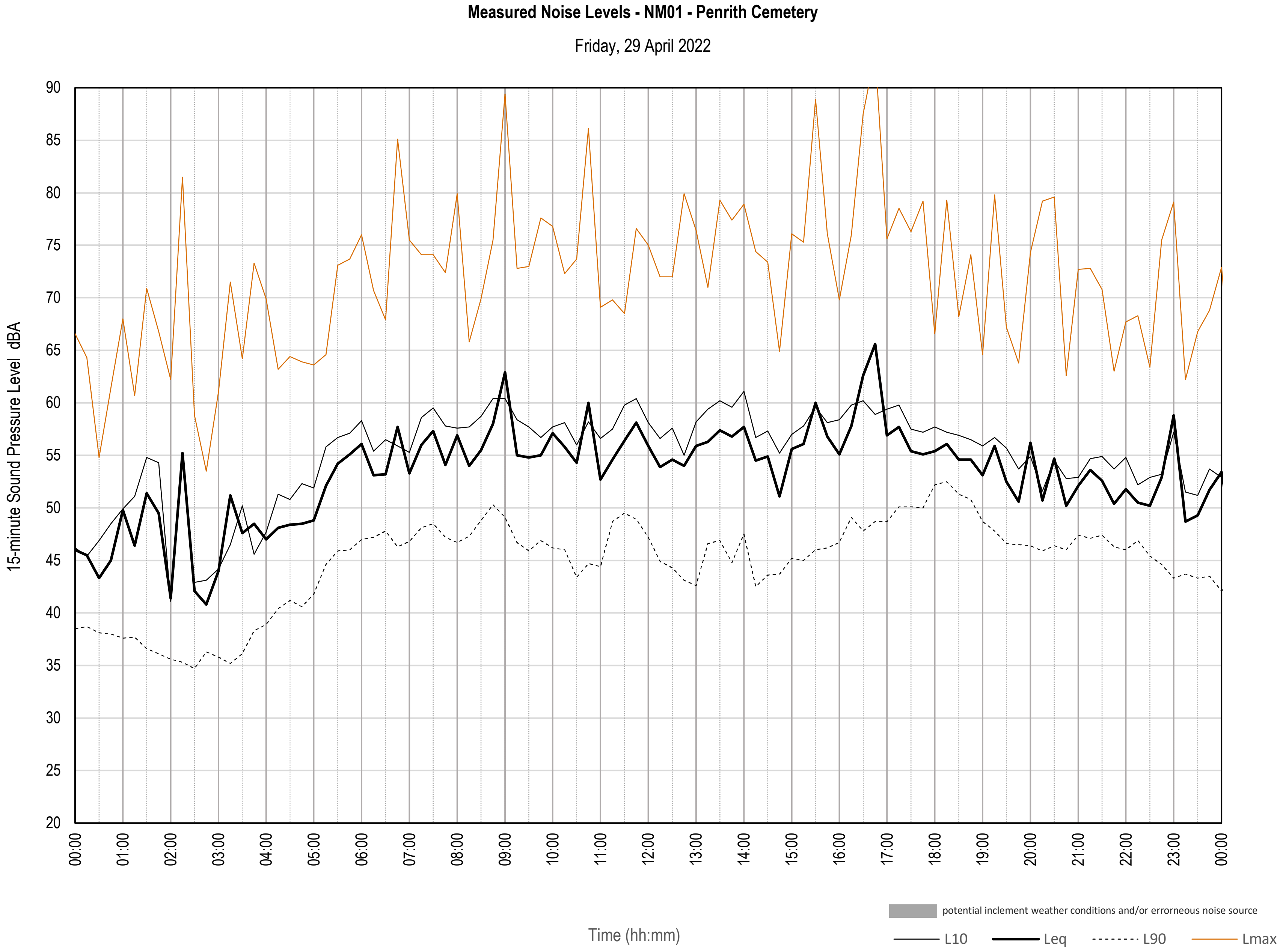

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Friday, 29 April 2022
15-minute Sound Pressure Level dBA
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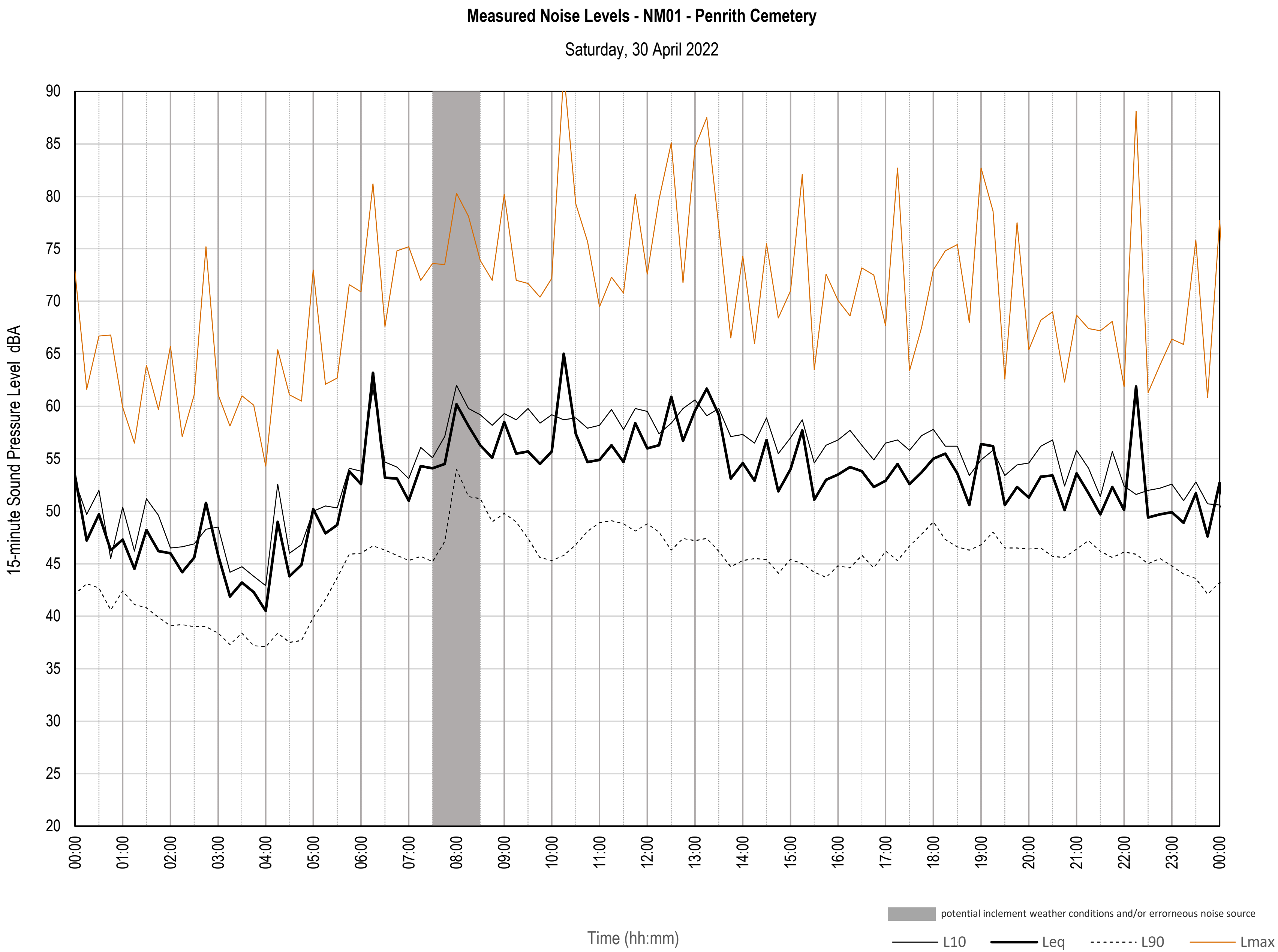
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Saturday, 30 April 2022
15-minute Sound Pressure Level dBA
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Time (hh:mm)
potential inclement weather conditions and/or erroneous noise source
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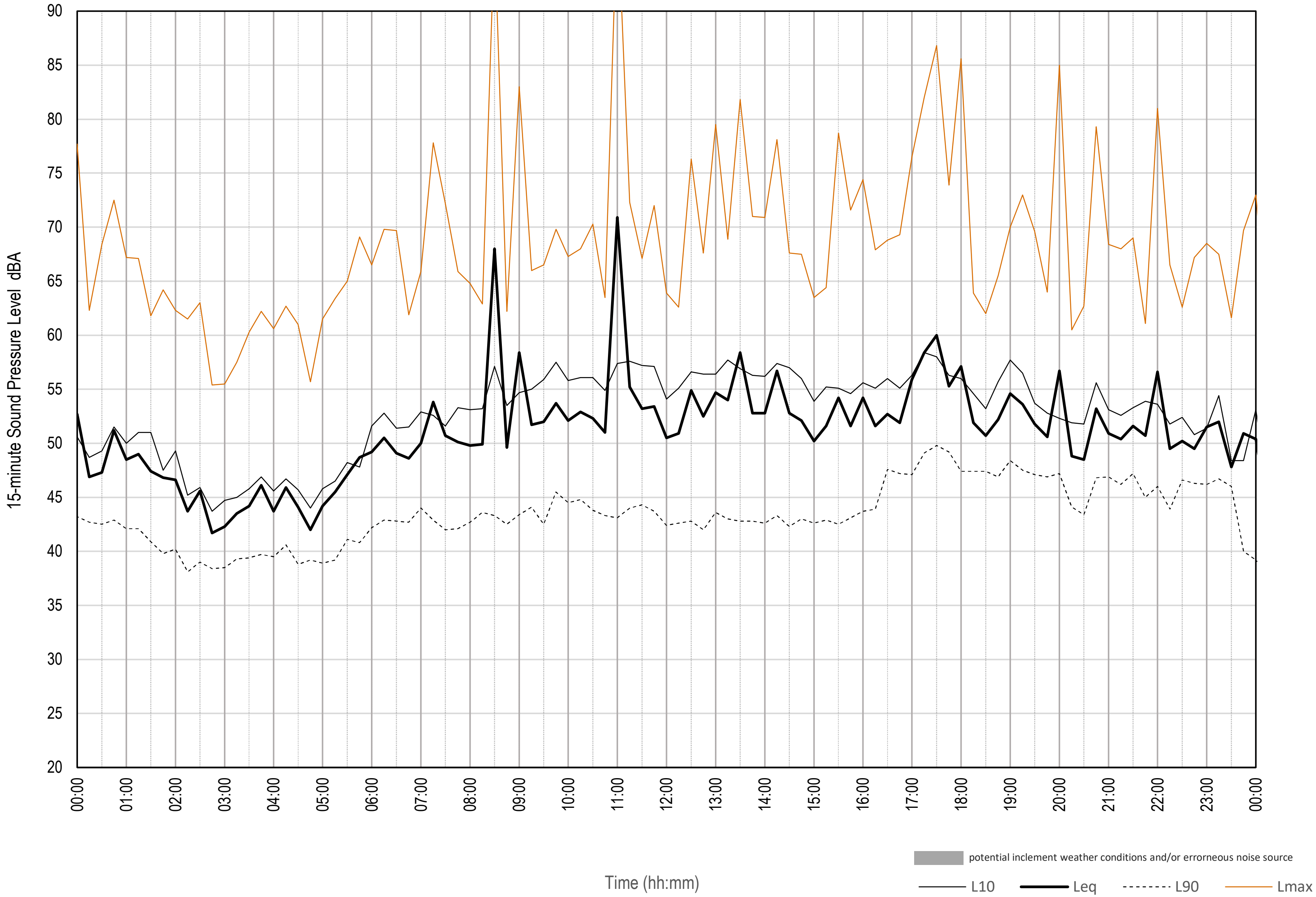
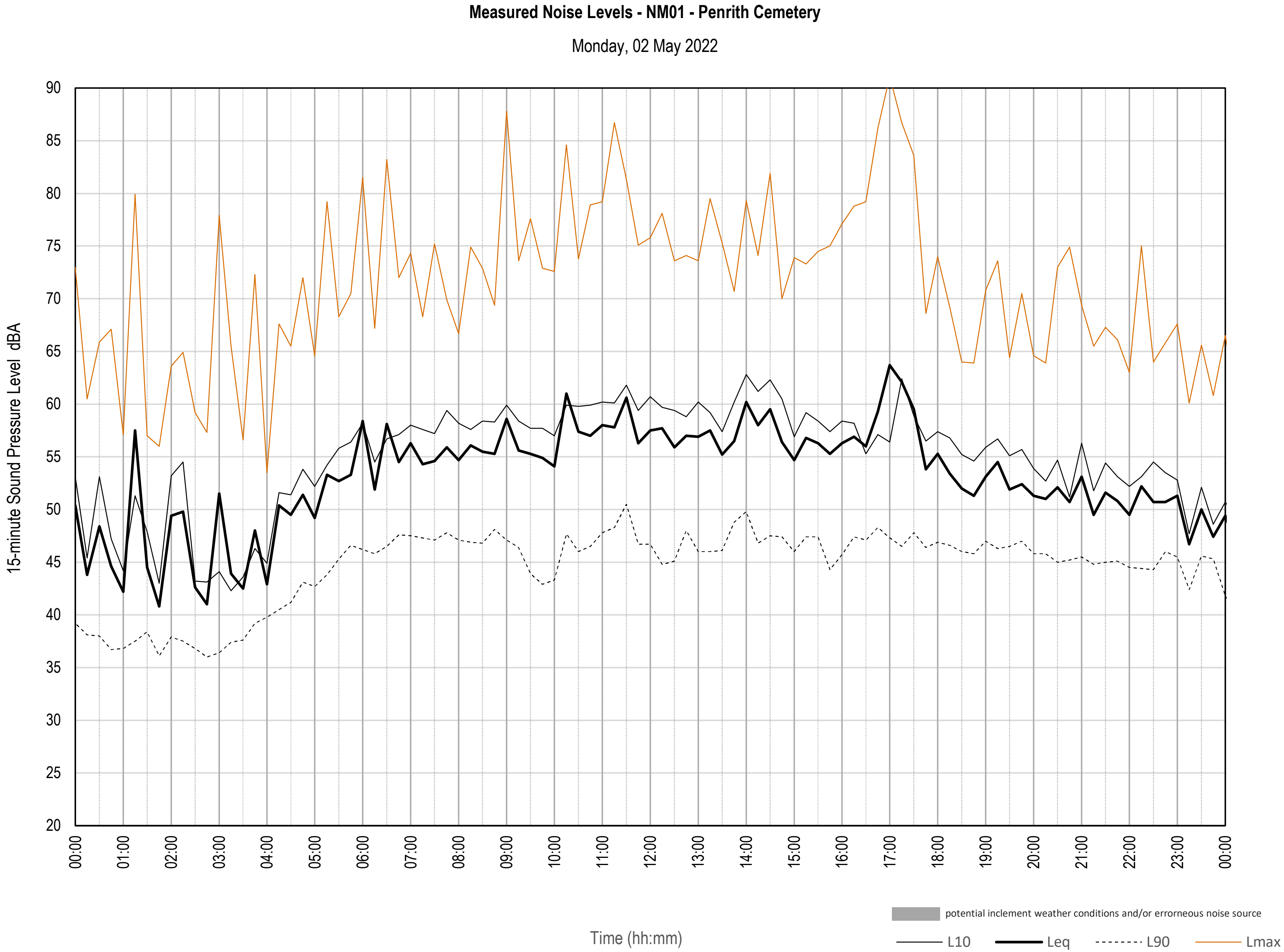
Measured Noise Levels - NM01 - Penrith Cemetery

Sunday, 01 May 2022




Measured Noise Levels - NM01 - Penrith Cemetery
Monday, 02 May 2022
15-minute Sound Pressure Level dBA
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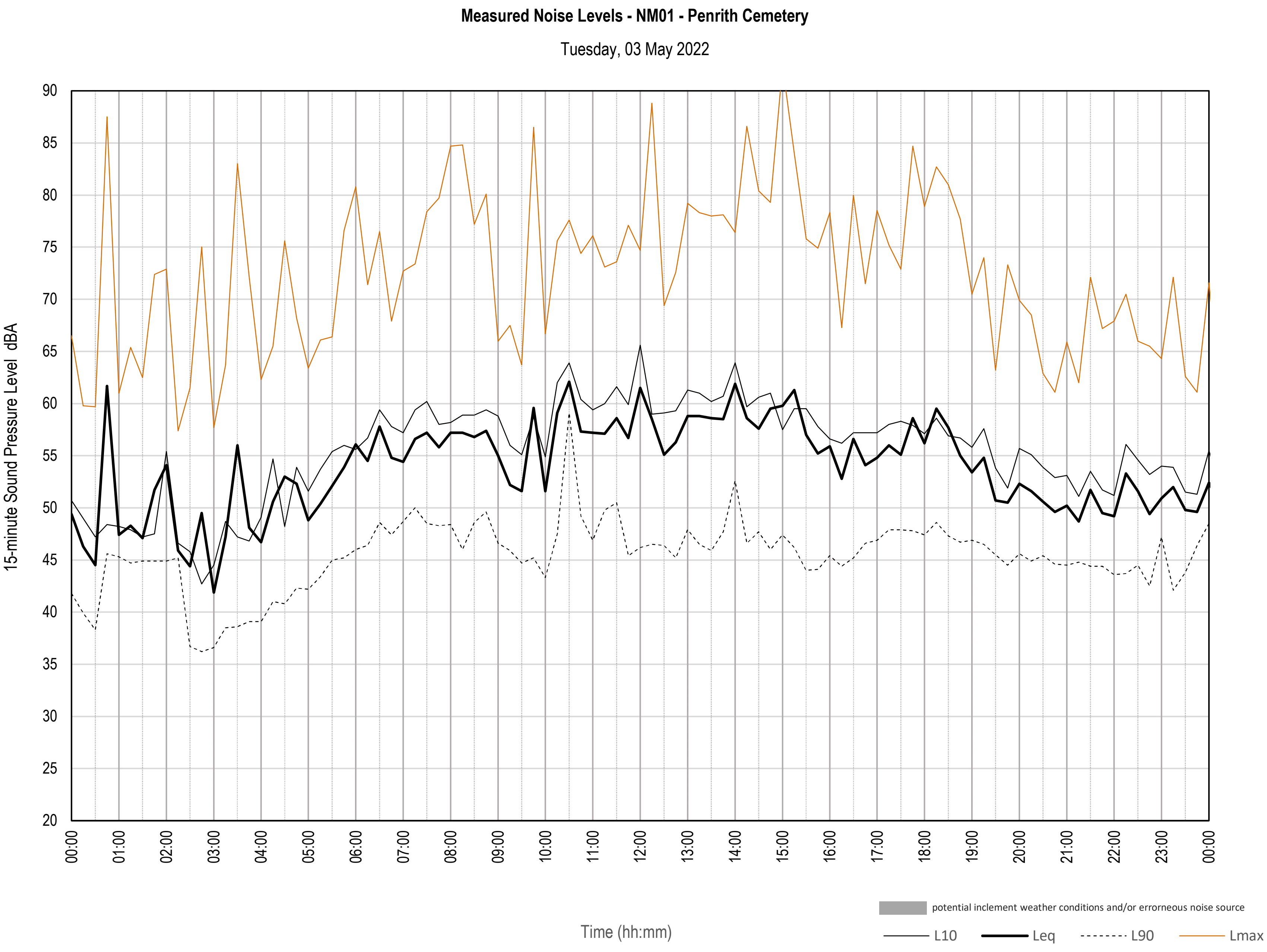
Measured Noise Levels - NM01 - Penrith Cemetery
Tuesday, 03 May 2022
15-minute Sound Pressure Level dBA
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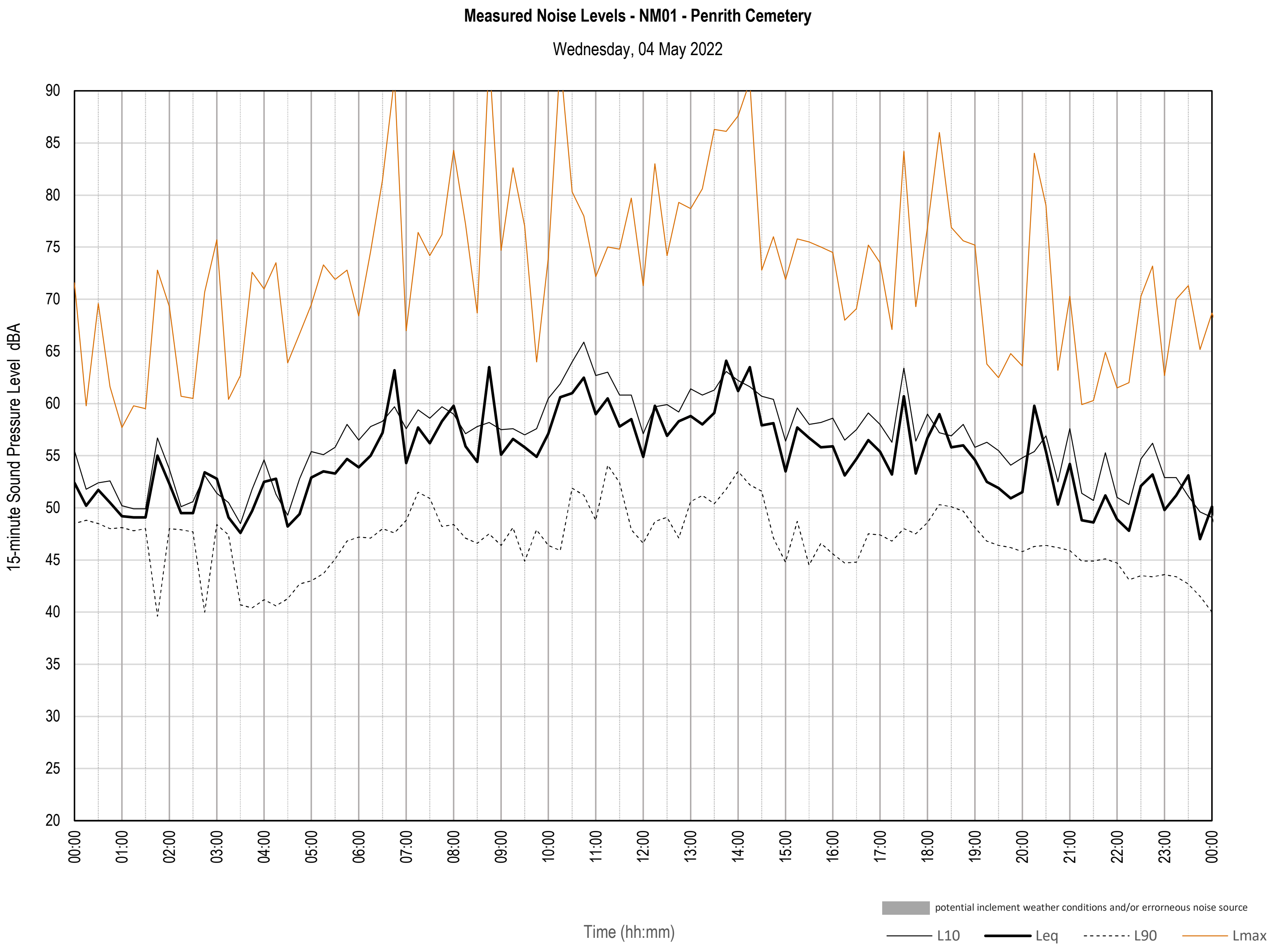

Measured Noise Levels - NM01 - Penrith Cemetery
Wednesday, 04 May 2022
15-minute Sound Pressure Level dBA
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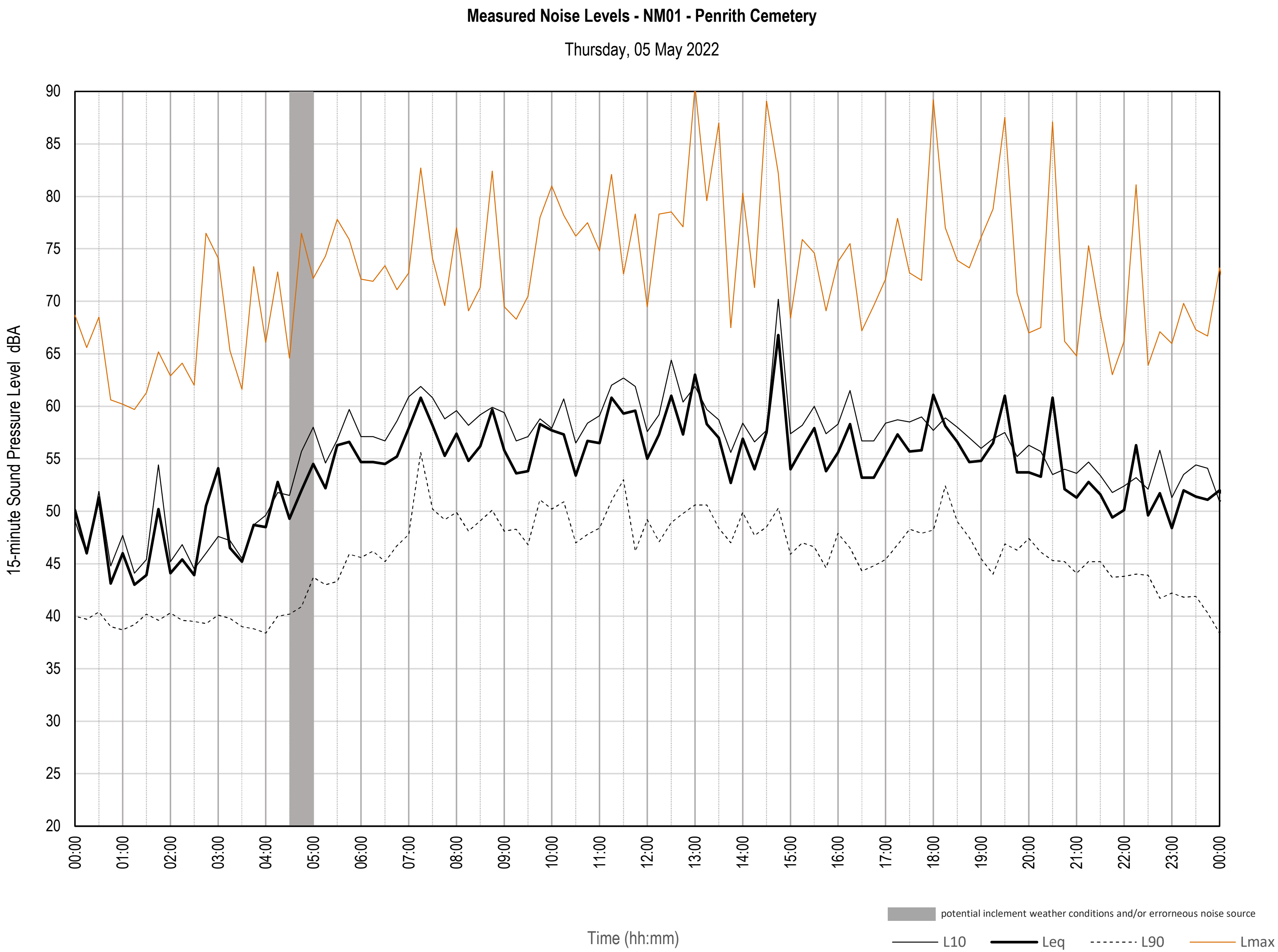
Measured Noise Levels - NM01 - Penrith Cemetery
Thursday, 05 May 2022
15-minute Sound Pressure Level dBA
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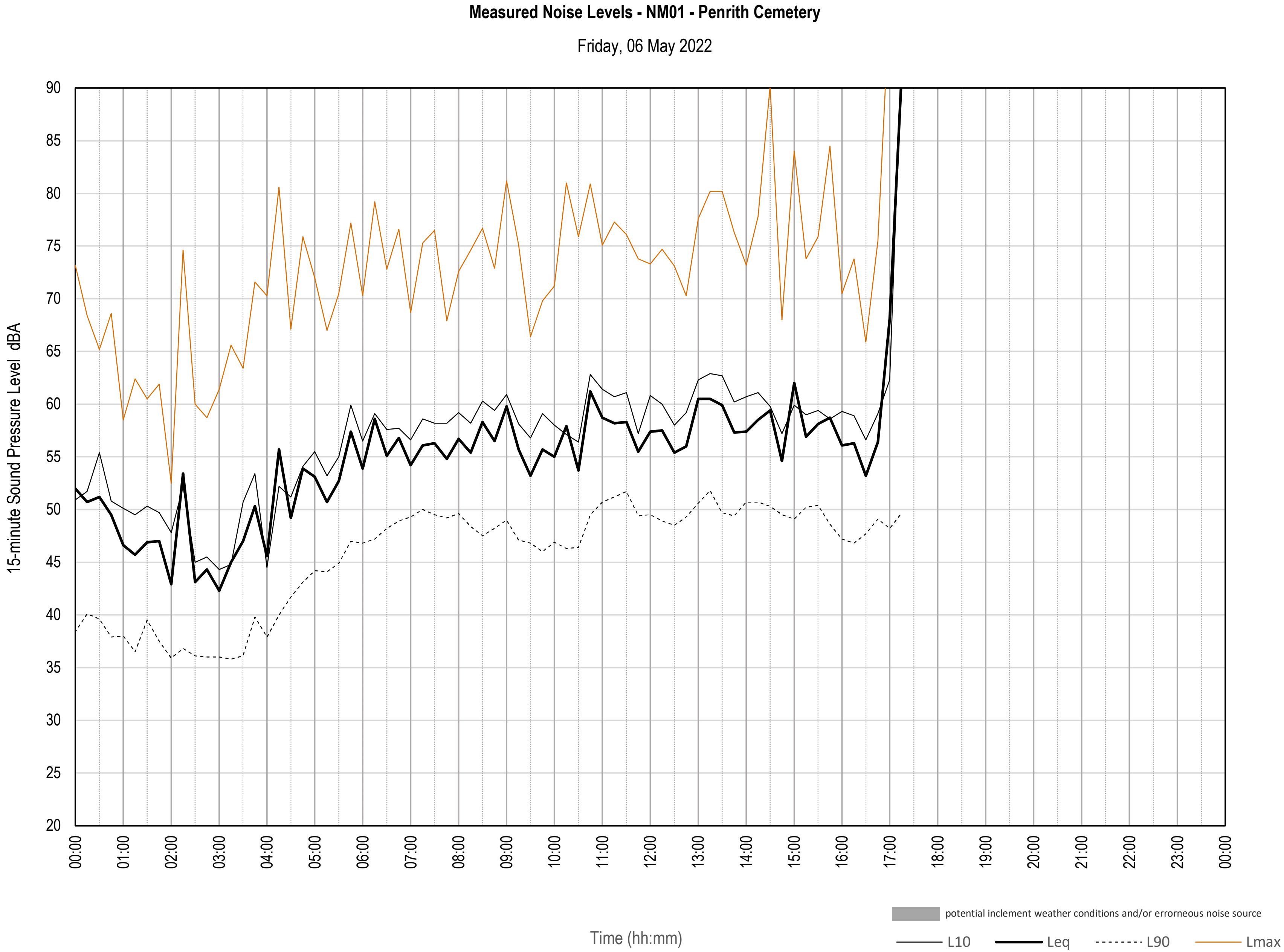

Measured Noise Levels - NM01 - Penrith Cemetery
Friday, 06 May 2022
15-minute Sound Pressure Level dBA
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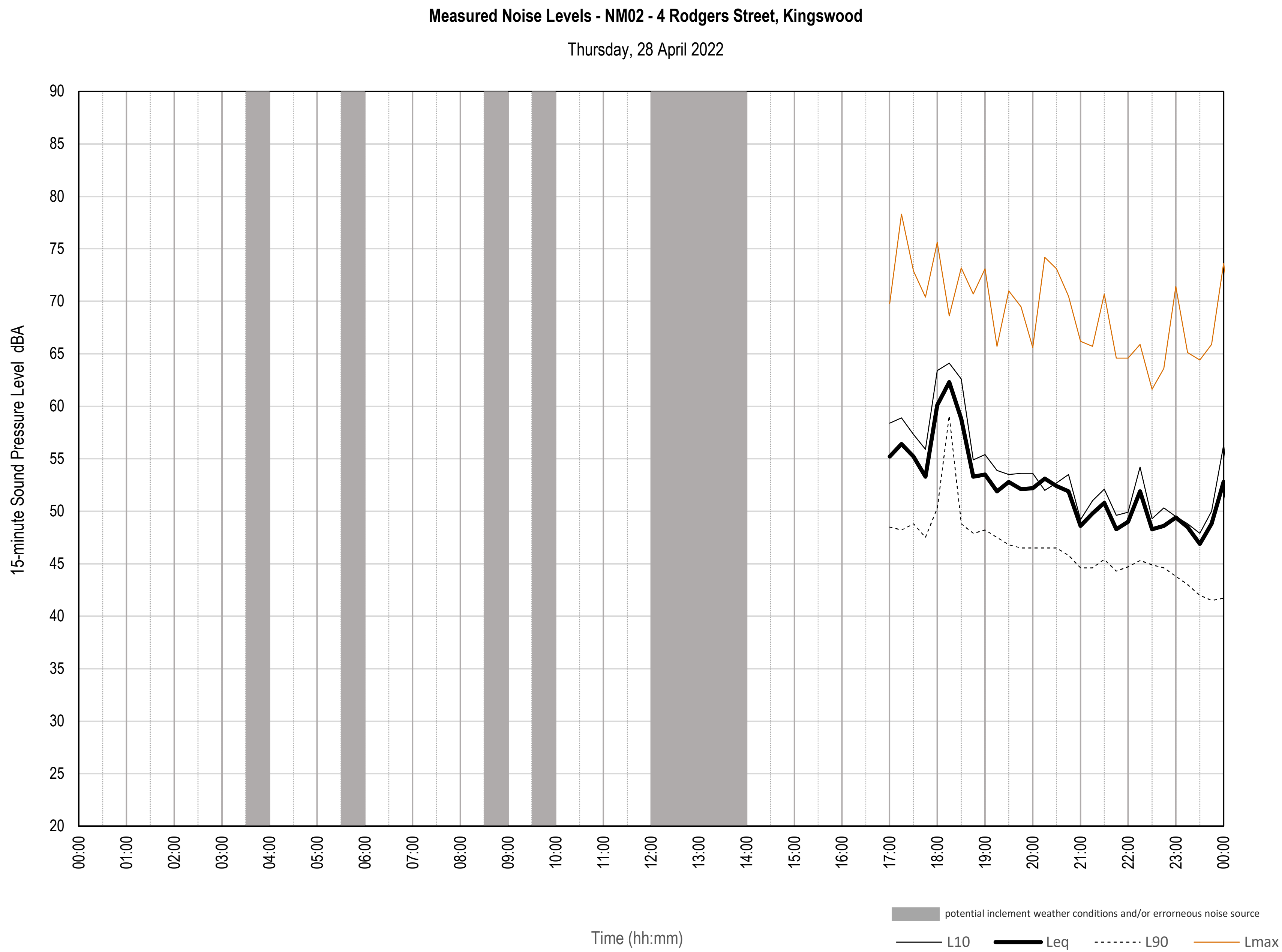

Measured Noise Levels - NM02 - 4 Rodgers Street, Kingswood
Thursday, 28 April 2022
15-minute Sound Pressure Level dBA
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Measured Noise Levels - NM02 - 4 Rodgers Street, Kingswood

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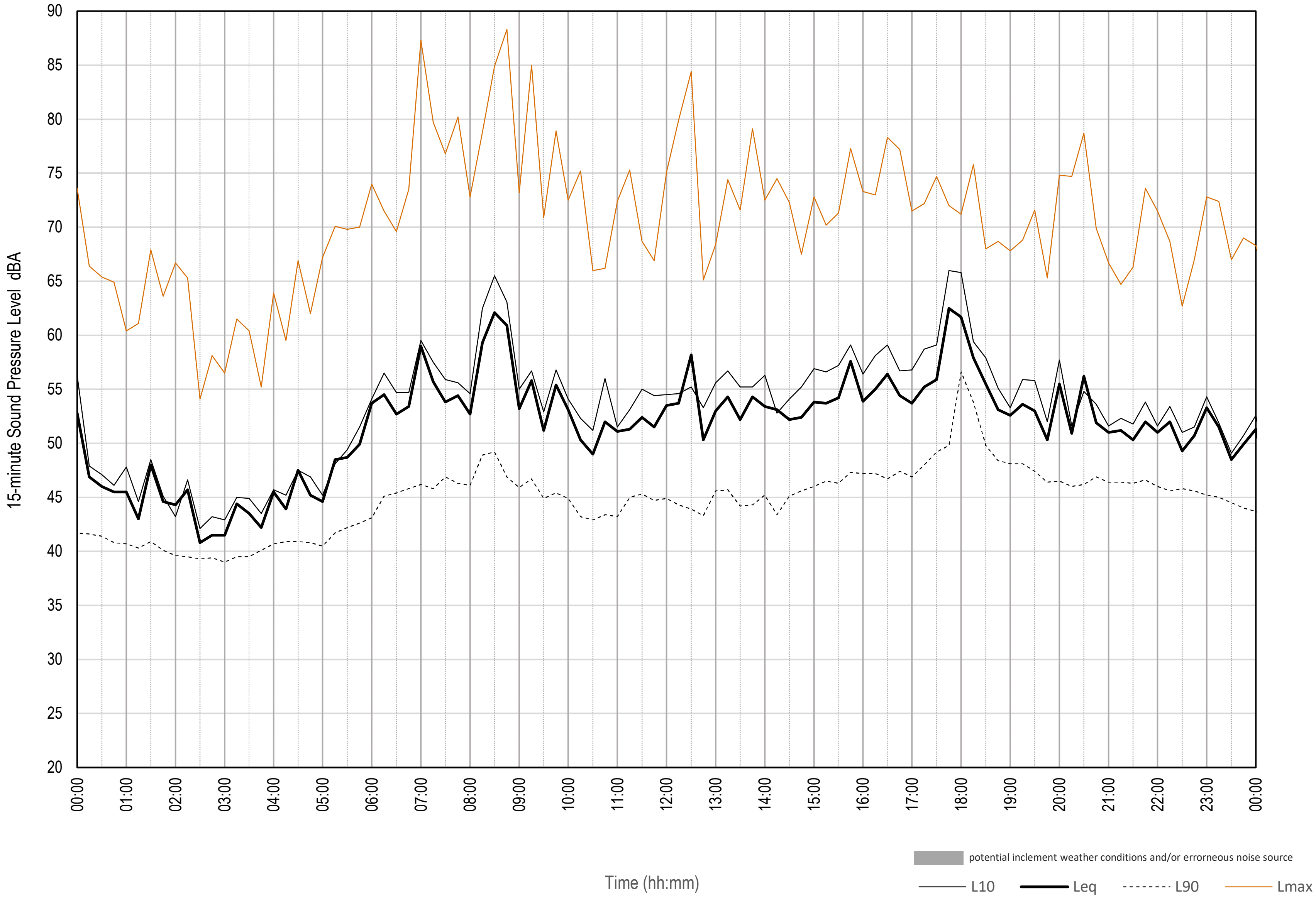

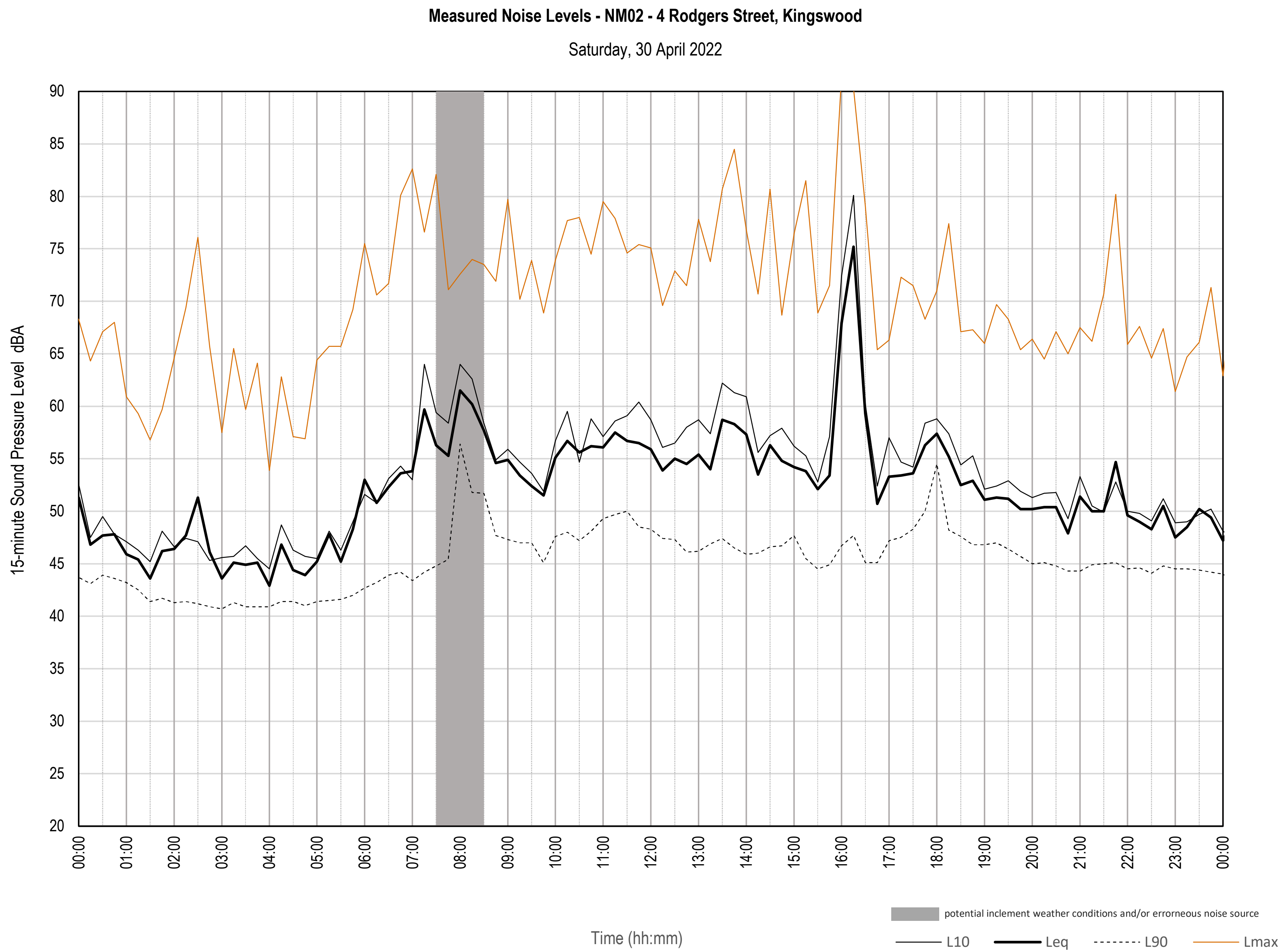

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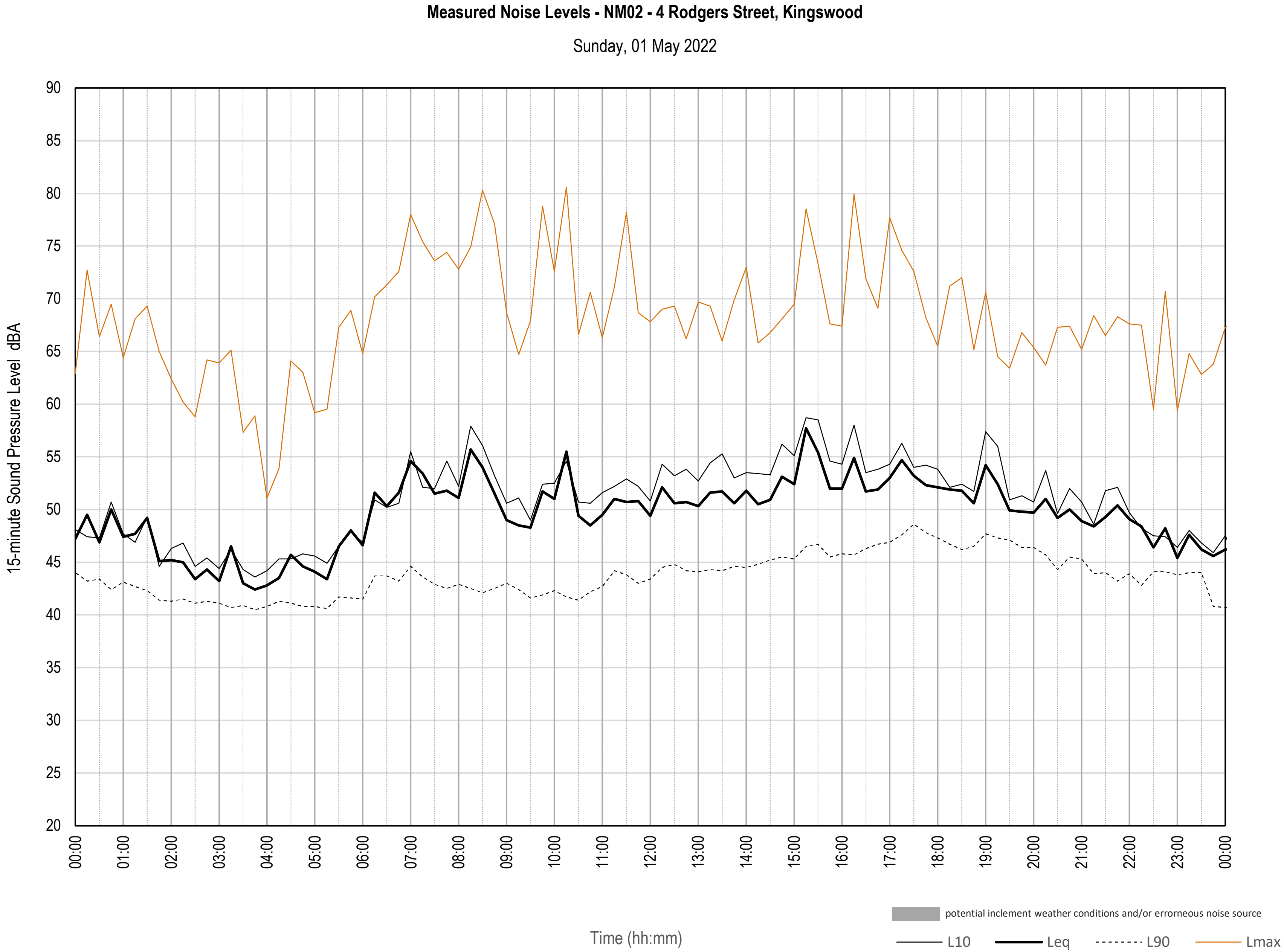

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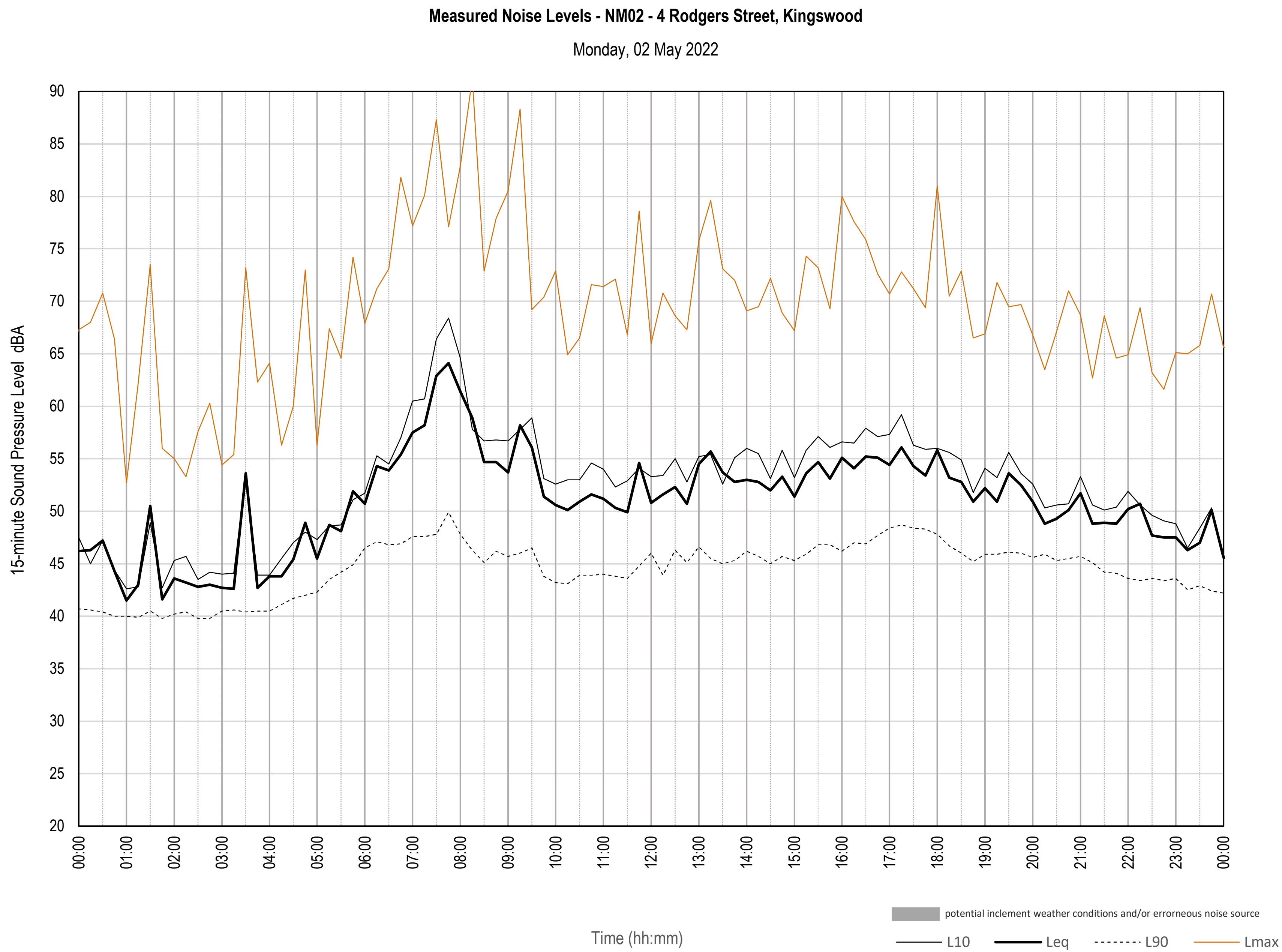

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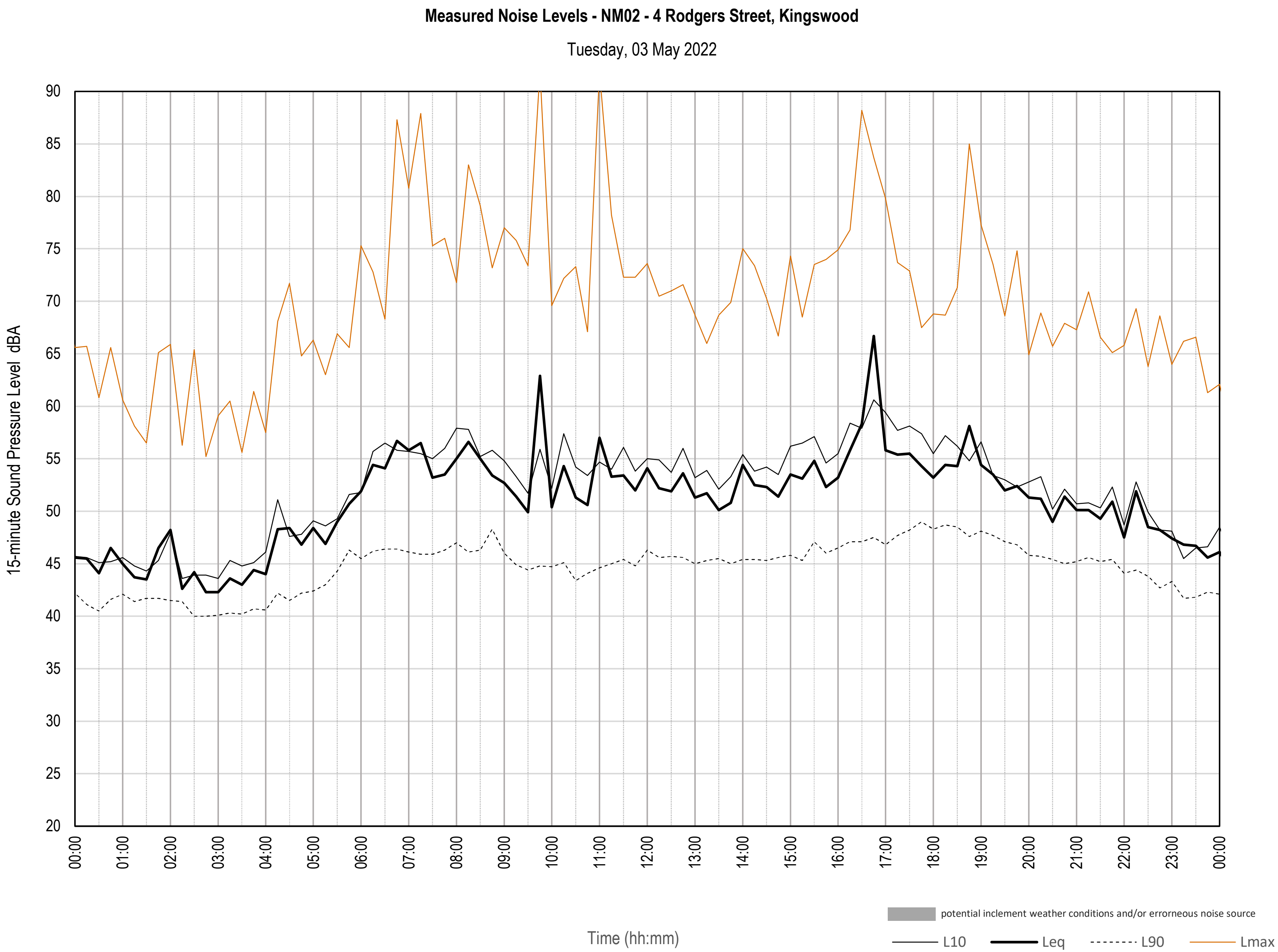

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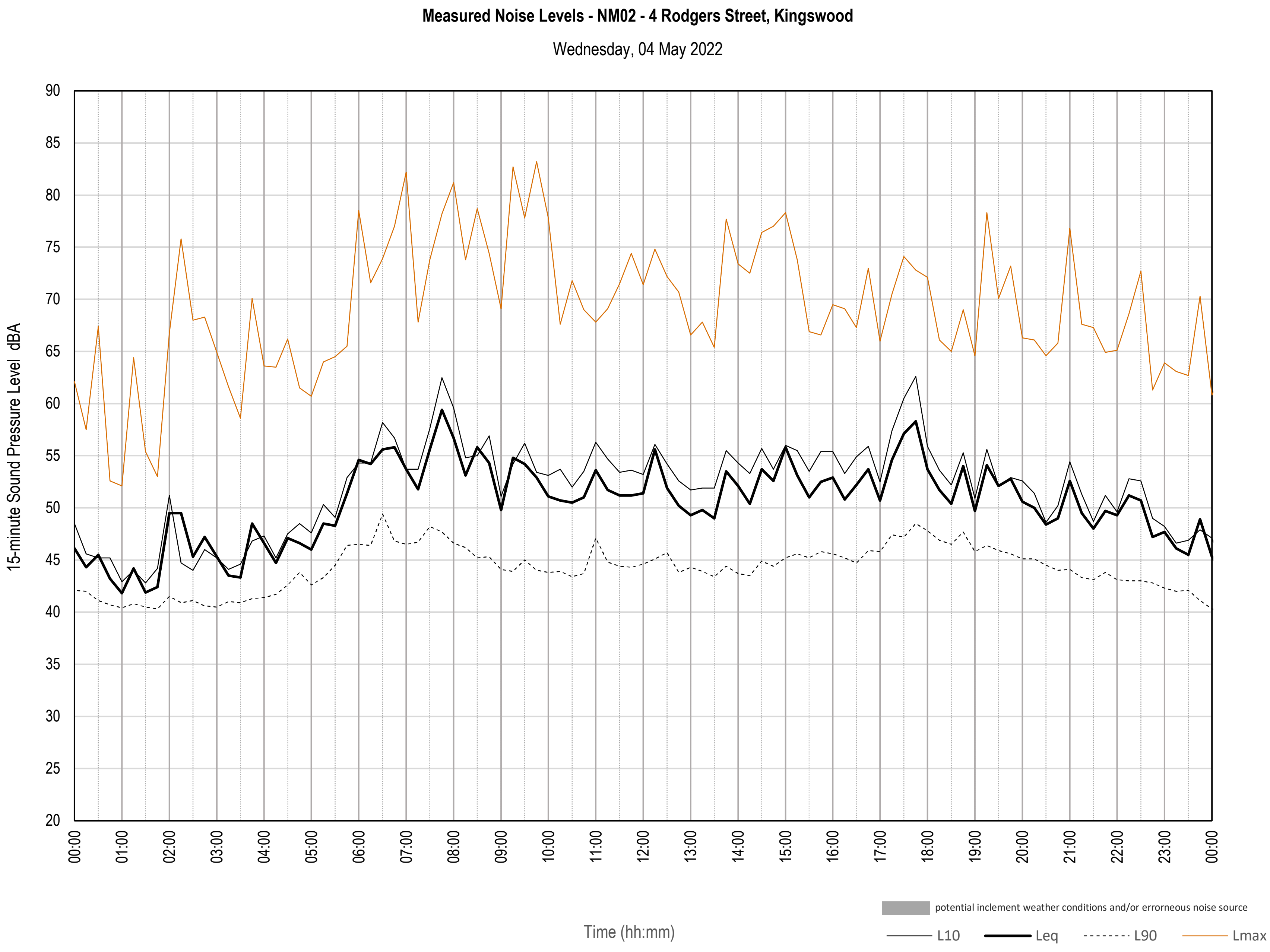
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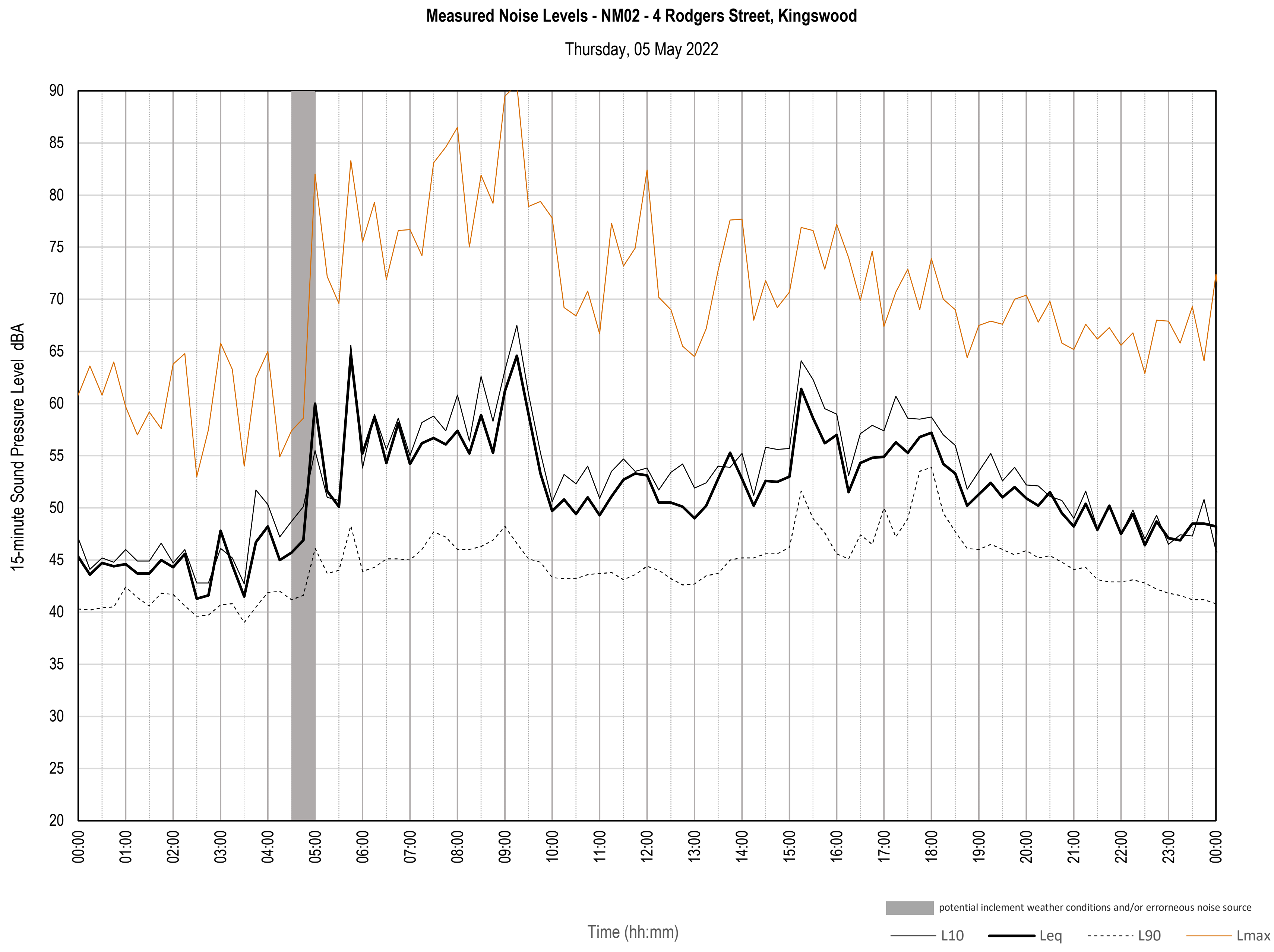

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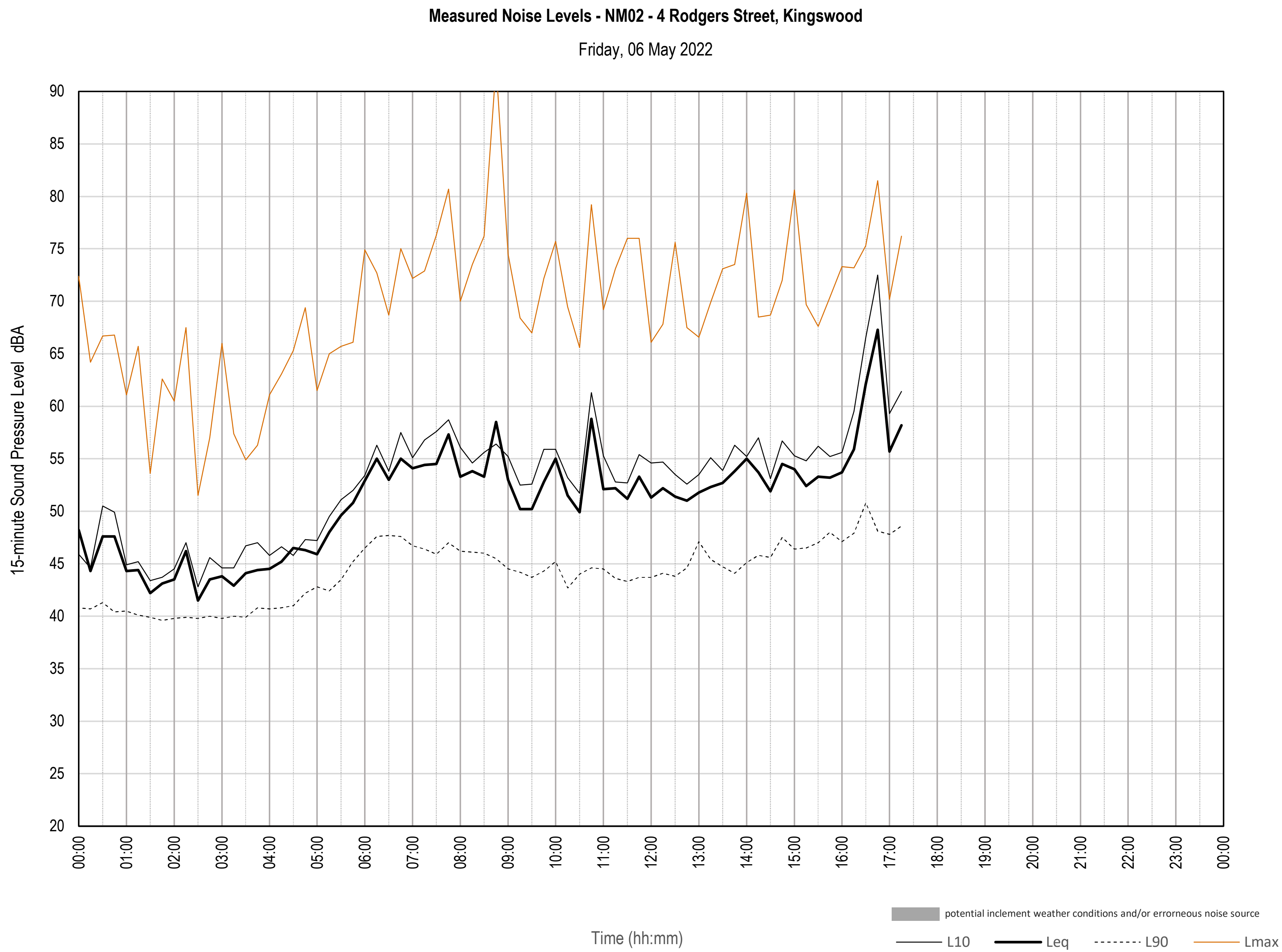
Measured Noise Levels - NM02 - 4 Rodgers Street, Kingswood
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Appendix B

Standard and Additional Noise and Vibration Mitigation Measures

B1 Standard Mitigation Measures

Table B.1 Standard management measures to reduce construction noise and vibration

ACTION REQUIRED	APPLIES TO	DETAILS
Implementation of any proposal specific mitigation measures required	Airborne noise Ground-borne noise & vibration	In addition to the measures set out in this table, any project specific mitigation measures identified in the EIA documentation (e.g. REF, submissions or representations report) or approval or licence conditions must be implemented.
Implement stakeholder consultation measures (refer to Sections 8.2.1 and 8.3 for further details of community consultation measures)	Airborne noise Ground-borne noise & vibration	Periodic notification (monthly letterbox drop and website notification) detailing all upcoming construction activities delivered to sensitive receivers at least 7 days prior to commencement of relevant works. In addition to Periodic Notification, the following strategies may be adopted on a case-by-case basis: • Project Specific Website • Project Infoline • Construction Response Line • Email Distribution List • Web-based Surveys • Social Media • Community and Stakeholder Meetings and • Community Based Forums (if required by approval conditions).
Register of noise and vibration sensitive receivers	Airborne noise Ground-borne noise & vibration	A register of most affected noise and vibration sensitive receivers (NVSRs) would be kept on site. The register would include the following details for each NVSR: • Address of receiver • Category of receiver (e.g. Residential, Commercial etc.) • Contact name and phone number. The register may be included as part of the Project's Community Liaison Plan or similar document and maintained in accordance with the requirements of this plan.
Construction hours and scheduling	Airborne noise Ground-borne noise & vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating noise with special audible characteristics and/or vibration levels should be scheduled during less sensitive time periods.

ACTION REQUIRED	APPLIES TO	DETAILS
Construction respite period	Ground-borne noise & vibration Airborne noise	Noise with special audible characteristics and vibration generating activities (including jack and rock hammering, sheet and pile driving, rock breaking and vibratory rolling) may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block. 'Continuous' includes any period during which there is less than a 1 hour respite between ceasing and recommencing any of the work. No more than two consecutive nights of noise with special audible characteristics and/or vibration generating work may be undertaken in the same NCA over any 7-day period, unless otherwise approved by the relevant authority.
Site inductions	Airborne noise Ground-borne noise & vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • All relevant project specific and standard noise and vibration mitigation measures • Relevant licence and approval conditions • Permissible hours of work • Any limitations on noise generating activities with special audible characteristics
Site inductions *continued*		• Location of nearest sensitive receivers • Construction employee parking areas • Designated loading/unloading areas and procedures • Site opening/closing times (including deliveries) • Environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors. No excessive revving of plant and vehicle engines. Controlled release of compressed air.
Monitoring	Airborne noise Ground-borne noise & vibration	A noise monitoring program should be carried out for the duration of works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Attended vibration measurements shall be undertaken at all buildings within 25 metres of vibration generating activities when these activities commence to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Construction Environmental Management Plans	Airborne noise Ground-borne noise & vibration	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.

ACTION REQUIRED	APPLIES TO	DETAILS
Building condition surveys	Vibration Blasting	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to major project construction activities with the potential to cause property damage.

Table B.2 Standard source measures to reduce construction noise and vibration

ACTION REQUIRED	APPLIES TO	DETAILS
Plan worksites and activities to minimise noise and vibration	Airborne noise Ground-borne vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Equipment selection	Airborne noise Ground-borne noise & vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable, see APPENDIX C. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits.
Maximum noise levels	Airborne-noise	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the allowable noise levels in APPENDIX C.
Rental plant and equipment	Airborne-noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the allowable noise levels in APPENDIX C.
Use and siting of plant	Airborne-noise	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers.
Non-tonal reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out-of-hours work, including delivery vehicles.
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Loading and unloading of materials/deliveries is to occur *as far as possible* from sensitive receivers.
Minimise disturbance arising from delivery of goods to construction sites *continued*		Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.

ACTION REQUIRED	APPLIES TO	DETAILS
Construction Related Traffic	Airborne noise	Schedule and route vehicle movements away from sensitive receivers and during less sensitive times. Limit the speed of vehicles and avoid the use of engine compression brakes. Maximise on-site storage capacity to reduce the need for truck movements during sensitive times.
Silencers on Mobile Plant	Airborne noise	Where possible reduce noise from mobile plant through additional fittings including: Residential grade mufflers Damped hammers such as 'City' Model Rammer Hammers Air Parking brake engagement is silenced.
Prefabrication of materials off-site	Airborne noise	Where practicable, pre-fabricate and/or prepare materials off-site to reduce noise with special audible characteristics occurring on site. Materials can then be delivered to site for installation.
Engine compression brakes	Airborne noise	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained original equipment manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.

Table B.3 Standard path measures to reduce construction noise and vibration

ACTION REQUIRED	APPLIES TO	DETAILS
Shield stationary noise sources such as pumps, compressors, fans etc	Airborne noise	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix F of AS 2436: 1981 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

B2 Additional Mitigation Measures

Table B.4 Additional mitigation measures

MEASURE	DESCRIPTION	ABBREVIATION
Periodic Notification	For each IP project, a notification entitled 'Project Update' or 'Construction Update' is produced and distributed to stakeholders via letterbox drop and distributed to the project postal and/or email mailing lists. The same information would be published on the TfNSW website (www.transport.nsw.gov.au). Periodic notifications provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage, inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on stakeholders. The approval conditions for projects specify requirements for notification to sensitive receivers where works may impact on them. Content and length is determined on a project-by-project basis and must be approved by TfNSW prior to distribution. Most projects distribute notifications on a monthly basis. Each notification is graphically designed within a branded template. In certain circumstances media advertising may also be used to supplement Periodic Notifications, where considered effective. Periodic Notification may be advised by the IP Community Engagement Team in cases where AMMM are not triggered as shown in Tables 9 to 11, for example where community impacts extend beyond noise and vibration (traffic, light spill, parking etc). In these circumstances the IP Community Engagement Team would determine the community engagement strategy on a case-by-case basis.	PN
Verification Monitoring	Verification monitoring of noise and/or vibration during construction may be conducted at the affected receiver(s) or a nominated representative location (typically the nearest receiver where more than one receiver has been identified). Monitoring can be in the form of either unattended logging (i.e. for vibration provided there is an immediate feedback mechanism such as SMS capabilities) or operator attended surveys (i.e. for specific periods of construction noise). The purpose of monitoring is to confirm that: • construction noise and vibration from the project are consistent with the predictions in the noise assessment • mitigation and management of construction noise and vibration is appropriate for receivers affected by the works Where noise monitoring finds that the actual noise levels exceed those predicted in the noise assessment then immediate refinement of mitigation measures may be required and the CNVIS amended. Refer to Section 8.4 for more details.	V

MEASURE	DESCRIPTION	ABBREVIATION
Specific Notification	Specific notifications are in the form of a personalised letter or phone call to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. Alternatively (or in addition to), communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities and provide an individual briefing. • Letters may be letterbox dropped or hand distributed • Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and their specific needs • Individual briefings are used to inform stakeholders about the impacts of noisy activities and mitigation measures that would be implemented. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project Specific notifications are used to support periodic notifications, or to advertise unscheduled works and must be approved by TfNSW prior to implementation/distribution.	SN
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. The offer could comprise pre- purchased movie tickets, bowling activities, meal vouchers or similar offer. This measure is determined on a case-by-case basis, and may not be applicable to all IP projects.	RO
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. Alternative accommodation would be determined on a case-by-case basis and should provide a like-for-like replacement for permanent residents, including provisions for pets, where reasonable and feasible.	AA
Alternative construction methodology	Where the vibration assessment identifies that the proposed construction method has a high risk of causing structural damage to buildings near the works, the proponent would need to consider alternative construction options that achieve compliance with the VMLs for building damage. For example, replace large rock breaker with smaller rock breakers or rock saws.	AC
Respite Period	OOHW during evening and night periods would be restricted so that receivers are impacted for no more than 3 consecutive evenings and no more than 2 consecutive nights in the same NCA in any one week, except where there is a Duration Respite. A minimum respite period of 4 evenings/5 nights shall be implemented between periods of evening and/or night works. Strong justification must be provided where it is not reasonable and feasible to implement these period restrictions (e.g. to minimise impacts to rail operations), and approval must be given by TfNSW through the OOHW Approval Protocol (Section 6). Note; this management measure does not apply to OOHW Period 1 – Days (See Table 1).	RP

MEASURE	DESCRIPTION	ABBREVIATION
Duration Reduction	Where Respite Periods (see management measure above) are considered to be counterproductive to reducing noise and vibration impacts to the community it may be beneficial to increase the number of consecutive evenings and/or nights through Duration Reduction to minimise the duration of the activity. This measure is determined on a project-by-project basis, and may not be applicable to all IP projects. Impacted receivers must be consulted and evidence of community support for the Duration Reduction must be provided as justification for the Duration Reduction. A community engagement strategy must be agreed with and implemented in consultation with IP Community Engagement Representatives.	DR

ABOUT US

WSP is one of the world's leading professional services consulting firms. We are dedicated to our local communities and propelled by international brainpower. We are technical experts and strategic advisors including engineers, technicians, scientists, planners, surveyors and environmental specialists, as well as other design, program and construction management professionals. We design lasting solutions in the Transport & Water, Property & Buildings, Earth & Environment, and Mining & Power sector as well as offering strategic Advisory, Engagement & Digital services. With approximately 6,100 talented people in more than 50 offices in Australia and New Zealand, we engineer future ready projects that will help societies grow for lifetimes to come. www.wsp.com/en-au/.

Appendix H

Arboricultural assessment

arboricultural impact assessment report

AIA-01

Revision A, Issued for REF Submission
9 June 2022

PROJECT

Commuter Carpark

Cox's Avenue Kingswood, NSW 2747

CLIENT / PRINCIPAL

WSP Australia

Level 27, 680 George Street
Sydney, NSW 2000

arterra
CONSULTING ARBORICULTURE

ARTERRA DESIGN PTY LTD ABN 40 069 552 610
SUITE 602, 51 RAWSON STREET, EPPING NSW 2121
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CONTENTS

i EXECUTIVE SUMMARY

This report supports a Proposed Development undertaken by Penrith City Council (Council) for the proposed demolition and reconstruction of a multi-storey commuter carpark for Kingswood station in Cox's Avenue, Kingswood (the site). Arterra was originally engaged by The Root Partnership, acting as project managers for Council, to undertake a preliminary arboricultural assessment of the site and prepare relevant reports and plans to help guide the re-development. Arterra was then subsequently engaged by WSP Australia Pty Ltd, on behalf of Council to provide this Arboricultural Impact Assessment as part of the Review of Environmental Factors for the project.

A detailed tree assessment was completed on 3 February 2021, with a brief follow up visit completed on 5 June 2022 to confirm that trees were still present and to include a row of small trees directly adjoining the Station buildings. A tree impact assessment schedule was completed for the trees on site. (Refer to Appendix 4.2 – Tree Impact Assessment Schedule). The trees were photographed, given a unique identification number and plotted onto a scaled survey base plan for referencing and identification throughout the report and for future discussions and co-ordination with Contractors and other stakeholders.

A total of **34** trees were assessed for this report. These are the trees that would be considered 'trees' under the Council's DCP or trees considered capable of reaching 6m in height in the near future. Very small trees, shrubs (<6m) and dead trees have typically not been included in the assessment.

The following points arise from the impact assessment:

- **27** trees are identified to be **removed** due to being within the footprint of the proposed building or being unacceptably impacted by the proposed and required regrading, repaving and services connections required through the reconfigured concourse / accessway between the commuter car par and the Station building.
- **7** trees (T26-T32) are identified to be **retained.** These trees are mainly outside the area directly impacted by the works. **Two trees (T30 and T32)** may experience a 'minor encroachment' (<10%) into the TPZ, as defined by AS4970-2009 Protection of Trees on Development Sites.

Trees T26-T32 are relatively small Australian native trees growing in a narrow garden bed on the southern boundary of the study area, between the station infrastructure to the south and an existing concrete pedestrian pathway to their north. A raised concrete kerb and the pathway separates these trees from the area expected to be impacted by the proposed works. Most of these trees are relatively small with nominal TPZs that don't extend beyond the northern edge of the existing concrete pathway. They are therefore expected to be retained without any impacts. One tree (**T30)** is a slightly larger *Melaleuca styphelioides* (Prickly Paperbark) and one tree (**T32)** is a small *Melaleuca quinquenervia* (Broad-leaf Paperbark) with nominal TPZs that extends beyond the northern edge of the existing concrete pathway. The levels expected to be required for the adjoining works and the pre-existing concrete pathway and kerbs means that the level of disturbance to this tree is expected to be minor. Disturbance within the nominal TPZ radius of this tree is expected to be largely related to the preparation of surface pavements only.

The proposed works may result in an 'incursion' of 10% to **T30 and T32**. In the author's opinion there is a likelihood that root development to the north of the trees has been naturally inhibited. These species also have recognised tolerance to root disturbances. They are therefore unlikely to experience any significant impacts from the proposed works as long as the appropriate tree protection measures are implemented and adhered to throughout the course of the project. Refer to See Appendix 4.1, T-02 'Tree Protection & Removal Plan' for further details.

As with all aspects in the development and construction process, the tree related constraints have to be weighed up against many other relevant development opportunities and constraints. The retention and removal of the trees on the site must also consider economic, social, environmental, construction and practical realities. This document has been prepared by Arterra Design Pty Ltd, using the expertise of our in-house consulting arborist (AQF Level 5), Robert Smart. Robert is a member of the International Society of Arboriculture - Australian Chapter and is also a Registered Consulting Arborist with Arboriculture Australia.

Robert Smart AAILA , ISA, AA
Director, Registered Landscape Architect (054), Registered Consulting Arborist (1804).

1.0 INTRODUCTION

1.1 Background

This report supports a Review of Environmental Factors (REF) for the project being undertaken by Penrith City Council (Council) relating to the proposed demolition of an existing at-grade car park and the construction of a new commuter carpark at Kingswood Railway Station on the corner of Cox's Avenue and Richmond Road, Kingswood (the study area). The proposed work involves the construction of a 14 metre (m) high multi-storey car park adjacent to the Kingswood Station. The new car park would provide approximately 300 additional commuter car parking spaces and integrate into the existing road and pedestrian network.

Arterra was originally engaged by The Root Partnership, acting as project managers for Council, to undertake an arboricultural assessment of the site and prepare the relevant preliminary reports and plans to help guide the re-development. Arterra was then subsequently engaged by WSP Australia Pty Ltd, on behalf of Council, to provide this Arboricultural Impact Assessment as part of the Review of Environmental Factors for the project.

Figure 1 – Site location and context –and study area. (Source: WSP)

This assessment was restricted to the trees within, or immediately adjacent to the site that were likely to be impacted by the proposed works. Other trees outside the extent of the proposed works, and unlikely to be impacted, are not addressed as part of this report. The proposal is to:

- Demolish the existing at-grade car park and surrounding infrastructure;
- Construct a new multi-storey car park and a related new pedestrian plaza accessing Kingswood Station.

Arterra completed an assessment of the existing trees that identified the trees and ranked their relative significance, health and retention values. This work was distributed to the client and the design team to help guide the development proposals. This impact assessment has been prepared to clearly identify the trees to be retained and removed as part of the development and so that the Council can take a proactive approach to managing the trees to be retained by implementing appropriate measures to manage and protect them during the construction.

The proposed demolition and construction work will require the removal of most of the trees on, and near, the site. The trees to be removed are not discussed at length within this report. The trees recommended for retention are mainly outside the area directly impacted by the proposed works and are discussed further in Section 2.0 - Key Findings and Observations.

Figure 2 – Site context – Council carpark site outline shown in red. Virtually all trees are located on the adjoining TfNSW land. (Source: Arterra / NearMap 05/03/2021)(Source: Nearmap/ Arterra)

1.2 Aims of This Report

The aim of this report is to assess the impact of the proposed development on the existing trees within the site. Specifically the report aims to:-

- Assess the health and condition of the trees;
- Accurately record information relevant to the existing trees;
- Assess the significance, Safe Useful Life Expectancy (SULE) and retention values of the existing trees;
- Provide clear recommendations as to which trees should ideally be retained and protected;
- Identify the proposed Tree Protection Zones (TPZ) of the tree being retained and identify and assess the likely arboricultural impacts of the development on the trees; and
- Provide advice on the tree protection measures that will be required during construction to ensure the trees are successfully retained.

The following limitations apply to this report's use: -

1. Plans: All plans are based on information provided to Arterra. They should only be used relating to tree issues and are not suitable for any other purpose.
2. Notification of proposed alterations to disturbance within TPZs: Arterra must be clearly notified of any proposed alterations to the plans or additional disturbance in TPZs, so that we can advise on the implications before any work is undertaken.

1.3 Relevant Controls or Legislation

Penrith Council planning instruments that apply to the site's trees:-

- Local Environment Plan 2010 (PLEP 2010)
- Development Control Plan 2014 (PDCP 2014) - PDCP Part C2- Vegetation Management

A tree for the purposes of this report and as prescribed under section 5.9 of the PDCP 2014, is defined in Appendix F1 of the PDCP 2014. A Tree means: a living perennial plant that has a height of three (3) metres or more or a trunk circumference exceeding 300mm at 400mm above ground level or individual trees, gardens or native vegetation listed as Significant Trees and Gardens.

It is our understanding the site is not a listed heritage item in the LEP nor does the site contain any trees listed on Council's Register of Significant Trees.

1.4 Conduct and Author Qualifications

Given the above stated aims of this report, as author of this report, Arterra confirms that Robert Smart is a suitably qualified (AQF Level 5) Consulting Arborist, to provide comment and the required arboricultural advice pertaining to these matters. Robert Smart is a member of the International Society of Arboriculture - Australian Chapter, a Registered Consulting Arborist with Arboriculture Australia and a licenced Quantified Tree Risk Assessment practitioner. Robert Smart has 25 years' experience in managing trees in complex development sites.

Furthermore, Mr Smart confirms that he has read and agrees to be bound by the NSW Uniform Civil Procedure Rules 2005, Part 31 Division 2 Provisions, Schedule 7 - Expert witness code of conduct.

Arterra provides specialist consulting arborist services only and does not provide any physical tree services such as climbing, pruning, removal, root investigations or root pruning. Our advice is based on impartial professional assessment only, as we do not derive any financial benefit from specifying pruning or other physical services. We will not specify any such activities unless we determine them to be essential to ongoing tree health or stability.

1.5 Key Definitions and Abbreviations

The following abbreviations are used throughout this report.

"TPZ" = Tree Protect Zone
This is the area as defined by AS 4970 – "Protection of Trees on Development Sites" and means the typical minimum area above and below ground at a given distance from the trunk to provide for protection of the tree. Most importantly it represents the root zone required to be left undisturbed to maintain a healthy and viable tree. Please note, that roots will usually extend well beyond this zone, so this represents the minimum remaining root zone required, assuming all others are lost or damaged due to construction. It is typically calculated as a circle centred on the trunk unless existing site conditions can be assessed and indicate otherwise.

"TPA" = Tree Protection Area
Although based on the nominal TPZ described above, this is a consolidated and often simplified area to be applied during construction for tree protection. This area is often shaped to deal with practical construction realities whilst maintaining appropriate protection of the nominal TPZ (i.e fencing a nominal circular TPZ can be difficult and impractical. TPA areas often define a square or rectangular shape which includes the area calculated as the nominal TPZ). It often amalgamates and simplifies tree protection zones, particularly when they are overlapping and can be amended for items such as buildings, walls, pathways and existing fences. It also protects areas that are contiguous to the calculated nominal TPZ, which are to be applied when the nominal TPZ is not completely circular due to structures potentially impeding root growth, or when there is a necessary incursion calculated within the TPZ.

"SRZ" = Structural Root Zone
This is the area as defined by AS 4970 – "Protection of Trees on Development Sites" and means the area immediately around the base of the tree at a given distance from the trunk within which the woody roots and soil cohesion are considered vital to the structural stability of the tree. Disturbance, damage or removal of soil and roots within this area will typically render the tree unstable and require its removal. It is typically calculated as a circle, centred on the trunk, unless existing site conditions can be assessed and indicate otherwise.

DBH = Diameter at Breast Height
This is the diameter of the trunk measured at 1.4m above ground level.

DGL = Diameter at Ground Level
This is the diameter of the trunk measured at ground level, but just above any root flare.

Non-Destructive Digging
This is the process of safely excavating the ground surface to minimise the risk of damage to existing tree roots. This method is used to map and locate existing tree roots within the TPZ and/or SRZ and helps to guide and inform the installation and/or construction of proposed services and/or structures which are in close proximity to retained trees. This is often achieved through hand digging using a shovel, trowel and/or fork with care not to damage the bark and wood of any roots. Compressed air (air spade) or water vacuum extraction are appropriate non-destructive alternatives to hand digging. Much reduced pressures may be required to avoid stripping root bark and other live tissue. When this work occurs within a TPZ and/or SRZ of a tree to be retained, a qualified consulting arborist should always be present to monitor the works.

Inclusion or Included Bark Branch Union
Growth of bark at the interface of two or more branches on the inner side of the branch union which is unable to be lost from the tree and accumulates, or is trapped, between the acutely divergent branches. This can form a weakened branch union in some species.

Epicormic Growth
Juvenile shoots produced along branches or trunks from dormant or latent buds concealed beneath bark. Production can be stimulated by fire, pruning, wounding or root damage and when excessively produced may also be an indicator of tree stress or decline.

1.6 Documents Reviewed

Plans and documents referenced and reviewed as part of this tree impact assessment were:-
LTS Surveyors:-

- Levels and Detail Survey (Issued 14/01/21)

Sam Crawford Architects:-

- Architectural Plan Set Project 21.14 - Dated 22/04/2022
    - LG Floor, Rev P3
    - Ground Floor, Rev P3
    - LG Floor / Public Realm, Rev P3

LOCI Design Collective: Landscape Architecture:-

- Landscape Plan Set – For Tender, Revision A
    - L000 – Cover Sheet
    - L100 – Existing Trees
    - L200 – General Arrangement GF North
    - L201 – General arrangement GF South
    - L300 – Levels and set out GF North
    - L301 – Levels and set out GF South
    - L400 – Planting GF North
    - L401 – Planting GF South
    - L402 – Planting L1+L2+L3

We understand that no new services other than those noted and discussed in this report are proposed to be extended into or through the proposed TPAs and any existing services that are no longer required will be capped off and left in situ, if located under any trees to be retained.

1.7 Site Context & Location

The proposal site is situated directly north of the Kingswood Station approximately 49 kilometres west of the Sydney Central Business District. The proposal is located at 6 Cox Avenue, Kingswood on the corner of Cox Avenue and Richmond Road in the Penrith City Council Local Government Area (the proposal site). The new multi-storey car park would occupy the existing at-grade Council car park on Lot 1 DP 198211 which has 115 car parking spaces.

The majority of trees are growing in a mulched area situated between the southern boundary of the existing carpark and the railway station. Some of the trees are growing very close to the carpark boundary and their canopies overhang the first row of parking. There are a further eight trees (T26-T33) growing in a garden bed, hard against the station building, to the south of the project site. Historic aerial images from the Department of Spatial Services (NSW) indicate that the majority of trees were planted in the 1980s. There were no trees present on the site in 1978 (refer Figure 3).

Figure 3 – Context plan illustrating the site in 1978. No trees were present on site. (Source: NSW Spatial Services 05/03/2021)

1.8 Site Ownership and Zoning

The site is identified as Lot 1 DP 198211, located at 6 Cox Avenue, Kingswood on the corner of Cox Avenue and Richmond Road, zoned IN1: General Industrial and owned by Penrith City Council. The project also includes a portion of the Transport for NSW land (Lot 5 DP1187060) between the station and the carpark, immediately to the south of the existing carpark.

1.9 Assessment Methodology

On the 3 February 2021, Robert Smart of Arterra attended the site to undertake a detailed assessment of the trees within and immediately adjacent to the site and likely to be impacted by the proposed development. The trees' health and condition were assessed via a visual inspection undertaken from the ground only. Requisite tree data (including DBH, DGL, height & canopy spread, condition & proximity to services) were recorded using an Apple iPad and Filemaker Pro database. A follow up site visit was undertaken on 5 June 2022 to assess and measure eight additional trees located close to the project site, near the station.

The basic health and condition criteria that were inspected for each tree is summarised as follows: -

- Tree size, broad age-class and general balance of the tree;
- Above ground obstructions;
- Evidence of recent site disturbance;
- Canopy foliage size, colour and density;
- Dieback and epicormic growth;
- Trunk or branch wounding, branch tear outs and pruning history;
- Structural defects such as any co-dominant stems, cracks, splits, included bark, decay and
- Pests and disease evidence or occurrence.

All trees were photographed, given a unique identification number, tagged with an aluminium numbered plate and plotted onto a scaled base plan for referencing and identification throughout the report and for future discussions and co-ordination. The photographic record of trees and general site context was taken using the inbuilt Apple iPad camera and a Panasonic Lumix TZ220 digital camera. Files have been resized, dated, named and filed in accordance with normal office procedures and protocols. No other image manipulation has been undertaken.

Tree trunk diameters were measured using a metric diameter tape measure. Tree heights were measured using the two-point clinometer function of a Nikon Forestry Pro laser range finder. Canopy spreads were estimated by pacing out distances along the cardinal axis of the canopy and cross-referencing to survey information and aerial photos. Canopy position and extents were then altered on the plans to more accurately portray the canopy extent and position.

No specialised equipment or methods were employed to test for the extent of decay in any of the trees, apart from a nylon 'sounding' mallet. No plant samples were analysed or independently tested to verify or formally identify any pests or diseases.

Desktop Review and Research

Digital AutoCAD files of the proposed works were imported into Arterra's standard CAD software (ArchiCAD v24) and superimposed over the tree and site survey information. The extent of site disturbance was analysed for the proposed building works, landscaping, services and other site grading. An assessment was made of the likely extent of impacts on the TPZs, taking into account the likely construction impacts depending on the type of work being undertaken (ie: cut or fill, suspended slabs, decks, service trenches). Various area calculations and measurements were made in the CAD software of the likely incursions into the TPZs or SRZs.

Recent aerial photography data was obtained from the Nearmap website with aerial photos of the site dating from December 2021 imported into the above software for cross checking and assessment. (http://www.nearmap.com/ accessed 04/02/2021)

Climatic data was obtained from the Bureau of Meteorology using statistics from Penrith Lakes (AWS) weather station which is located approximately 6km from the site. (http://www.bom.gov.au/climate/data/ accessed 06/06/2022)

1.10 Pre-Development Tree Assessment – Tree Retention Values

The information gathered in the field was tabulated and the retention value assessed using a combination of techniques commonly used and recognised in the arboricultural industry. The tree life expectancy was established using the Safe Useful Life Expectance (SULE) system. A brief summary of these systems is provided below.

SULE

This is a system developed by Jeremy Barrell in 1993 that determines the time a tree may be expected to be retained based on its age, health, condition, safety and location. This is then moderated by the economics of maintenance or other costs of retaining the tree. A long SULE means the tree is presently expected to live longer than 40 years with minimal intervention and cost. A short SULE indicates a tree that is not expected to live longer than 5 years or may require substantial intervention or costs to retain it.

RETENTION VALUES

The proposed retention value of the trees was determined based on a considered combination of the size, age, condition and suitability of the tree. Each tree was then ranked according to one of 4 retention categories.

1. **"High" Retention Value** – these are trees that are typically in good or very good condition, large and visually prominent, historically or environmentally important. They may also be lesser quality trees, but part of an important grouping of trees. They should represent a serious physical constraint to the development and their removal avoided where possible and feasible.
2. **"Moderate" Retention Value** – these are trees that are in good to reasonable condition and should be retained where possible and feasible to do so. They may also be lesser trees, but part of an important grouping of trees and therefore warrant retention based on the group's value.
3. **"Low" Retention Value** – these are trees that are in poor condition or have structural defects, are particularly small or commonplace, are not historically, environmentally or socially significant and should not be considered as a constraint to the development. They could be retained only if they are not likely to be impacted by, or constrain potential desirable, development outcomes.
4. **"Should Remove" / No Retention Value** – these are trees that are in very poor health, exhibit poor form, or have serious structural defects, are considered weeds or combination of all these, and therefore should be considered for removal regardless of any development.

Consideration has also been given to the relationship of the trees to one another and their proximity to the likely development areas on the site. For example, trees that are part of a closely spaced group, or are likely to be significantly misshapen or unstable with the removal of surrounding trees and structures are considered with these factors in mind.

1.11 Tree Assessment – Tree Protection Zones

In order to ensure the long-term survival and growth of any tree to be retained on the development site, a suitable area is required to be protected around the tree. This area should typically be as large as possible. It should also take into consideration: -

- The size and age of the tree;
- Above and below ground properties;
- The health and condition of the tree;
- The species of tree and its tolerance to disturbance;
- Soil conditions, type, depth and site hydrology and
- Site specific conditions and any existing obstructions to root development

The Tree Protection Zones (TPZs) have been calculated using the formula and criteria outlined in AS 4970-2009 Protection of Trees on Development Sites. In summary the standard applies the calculation for the radius of the TPZ as 12 x (the tree trunk diameter (in metres) calculated at breast height (DBH)). DBH is taken at 1.4m above ground level.

A maximum TPZ radius will be 15m (unless crown protection is required) while the minimum TPZ radius shall be 2m. The TPZ is typically assumed to be radial and centred on the centre of the tree's trunk unless other site factors or tree canopy size and location dictate an adjustment. Encroachments of up to 10% of the area may be accepted within the TPZ as long as it is outside of the Structural Root Zone (SRZ). This is known as a "minor encroachment". Encroachments greater than this, known as "major encroachments" will only be accepted with additional specific evidence that the tree will not be unduly impacted.

Whenever an encroachment is made into a TPZ, a suitable compensation should be made elsewhere and physically contiguous to the remaining TPZ.

The Structural Root Zone (SRZ) is the area defined as the minimum area required to retain the structural stability of the tree. The formula for calculating the SRZ is outlined in AS 4970 Section 3.3.5. No encroachment into the SRZ shall typically be allowed.

2.0 KEY FINDINGS & OBSERVATIONS

2.1 The Proposed Development

In summary the development of the site involves the following:-

- Demolition and regrading of the existing at grade Council car park.
- Construction of a new multi-storey commuter car park over five levels with approximately 418 car spaces.
- Three vehicular access and egress points on Cox Avenue, Richmond Road and through the Transport for NSW at-grade car park.
- Construction of a new shared access road to the Transport of NSW at-grade car park off Richmond Road.
- Ancillary works including services diversion and/or relocation, drainage works, landscaping, installation of lighting, installation of handrails and balustrades and new infrastructure (including wayfinding signage and CCTV cameras).

The proposed works will result in significant building and site disturbances which will necessitate the removal of most of the trees, except those that are outside the area directly impacted by the demolition and construction works. The proposed development will involve:-

- Demolition works;
- Access to and from the site with large construction plant and cranes;
- Stockpiles of excavated material and demolition waste;
- Stockpiles/ storage of building materials;
- Re-grading, excavation and filling of the existing surface levels;
- Extensive trenching for services;
- Building works involving concreting, paving and general construction;
- Installation of services, extensive new vehicular rated paving and
- Landscaping.

Key Assumptions:-

- No temporary battering or grading is to be applied within the designated TPAs (refer accompanying Tree Protection and Removal Plan for extent of TPAs).
- Extensive new services for the building will will be required to the south of the multi-storey buildingand connecting to Richmond Road.
- Where no spot levels or proposed contours are indicated it is assumed that the existing surface levels are retained.
- It is assumed that any new landscape grading within the TPAs will be quite minimal with levels raised slightly and filling favoured over cutting.

2.2 Tree Assessment - General

A total of **34** trees were assessed for this report and were generally determined to be in fair to good health. They are predominantly located immediately to the south of the existing at grade car park, but on Transport for NSW land. Detailed information on each tree including; heights, trunk diameters, canopy spreads, age classes and condition are all provided in Appendix 4.2 - 'Tree Impact Assessment Schedule'.

Figure 4 – Photo towards Kingswood Railway station from Park Ave / Richmond Road intersection. (Photo: Arterra 03/02/2021)

Figure 5 – Photo towards Kingswood Railway station indicating T26-T31. (Photo: Arterra 05/06/2022)

Figure 6 – Photo towards Kingswood Railway station form the existing commuter carpark. (Photo: Arterra 03/02/2021)

2.3 Climate and Microclimate

Kingswood is located in Sydney's western suburbs, and therefore would share the general climate of this region with moderate temperatures, good rainfall and minimal climatic and weather extremes. It is typically described as a temperate climate with hot to warm summers and cool winters, with relatively uniform rainfalls greater than 800mm / year. There is no distinct dry season.

The site is located approximately 5.5km form the Bureau of Meteorology automated weather station at Orchard Hills. It has an average annual rainfall of 822mm, fairly evenly spread across the year but with a slightly drier period during the late winter and early spring months. The highest rainfall period is usually February with an average of 110mm and the driest month being July with an average of 36mm.

Maximum average daily temperatures range from 28.5ºC in December to 17.2ºC in July. The minimum average daily temperatures range from a high of 17.4ºC in February down to lows of 5.3ºC in July.

The primary wind direction is from the south or east in the afternoons while it is predominantly from the south and south-west in the mornings. This is common of coastal areas dominated by "sea breeze" affects. Sea breezes are caused by unequal heating and cooling of adjacent land and sea surfaces. A sea breeze is one that blows from the sea to the land in consequence of this differential heating. With a weak general wind circulation, a sea breeze will commence over the coastline soon after the land temperature begins to exceed the sea temperature (late morning to early afternoon). As the difference increases, so the sea breeze will become stronger and will extend farther inland. (Source: Australian Bureau of Meteorology)

The strongest winds (>40km/h) are normally experienced from the west or south-westerly directions and later in the day. There are no prominent microclimatic influences over the site.

2.4 Soils and Landform

Soil landscape mapping of the area describes the natural soils of the site as part of the Luddenham soil association, overlying Wianamatta Group Shales. The topsoil is expected to be a friable dark brown loam over a hardsetting brown clay loam with an apedal massive or weakly pedal structure. The soil is expected to be pedal, with localised impermeable highly plastic subsoil, with low wet strength and low available water capacity (Bannerman, 1990). They may be subject to high erosion.

Given the history of the site and its long term development as a railway station and carpark, the soils are likely to be highly modified from any soils that would have occurred naturally.

2.5 Tree Biology and Tree Care Basics

Trees are dynamic living organisms. Trees can be very susceptible to damage, stress and declining rapidly if overly impacted by construction. Trees take decades to grow but can be injured and killed in a very short time frame. This is particularly due to the irreparable damage to the often shallow, extensive and unseen root systems. It is rarely possible to repair a stressed or damaged tree, after the damage has occurred. Proper protection is the key to minimising construction related impacts. Severing of roots within the Structural Root Zone (SRZ) can also lead to potentially unsafe instability of the tree as a structure.

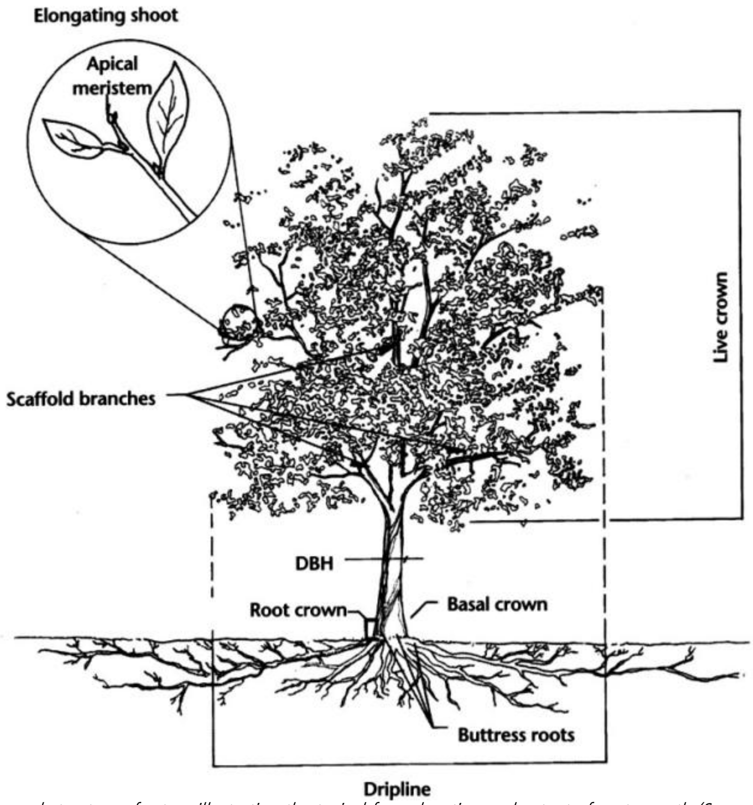


Figure 7 – Typical form and structure of a tree illustrating the typical form, location and extent of root growth (Source: Matheny and Clark, 1998)

<u>Basic Tree Needs</u>
As a living organism a tree remains alive by completing the following chemical reaction -
Carbon Dioxide and water in combination with chlorophyll and light is converted to Glucose and Oxygen [CO_2 + H_2O + light = sugar (CH_2O [Glucose]) + O_2]

The process ultimately leads to the plant cells 'respiring' and producing energy for survival, a natural requirement for all living cells. Anything that affects a plant's photosynthesis and then cellular respiration will affect the overall plant health. The limiting factors of photosynthesis and respiration will typically be the availability of oxygen, water and nutrients that make up the important chemical molecules and reactions.

Trees therefore have five basic requirements to survive and successfully grow:-

1. Oxygen (and particularly oxygen within the soil);
2. Water (a cellular necessity and primarily taken up by the tree roots);
3. Light & Sufficient Foliage (in order to photosynthesise and create the resources needed for cellular survival);
4. Soil (for physical anchorage and critical chemical nutrients) and
5. Physical Space (both above and below ground to grow).

Importantly, a minimum of 15% soil oxygen is required for active root growth and nutrient uptake. Less than 10% available soil oxygen starts to restrict root extension and growth and a minimum of 3% soil oxygen is required to just maintain root existence. Less than this will result in root death (Harris 1999).

One of the most insidious effects of construction on trees is often that of soil compaction or covering of root zones with impervious surfaces, as it:-

- Reduces infiltration rates of surface water;
- Reduces the availability of water to the roots as they can't naturally extract remaining moisture when soil becomes too dry;
- Reduces air to roots (roots cease to function properly and die without oxygen);
- Increased soil strength caused by compaction mean that roots need more energy to growth through it or can't even physically penetrate the soil;
- Roots are physically broken or crushed and there is increased potential for fungal and pathogen attack. (Harris 1999).

<u>Tree Tolerance</u>
Typically, older and larger trees are less tolerant of construction impacts. Different species also have different tolerance of injury and disturbance. Importantly it needs to be stressed, that a tree does not "heal" from injury as animals do. Typically, any injury made to a tree results in the tree expending considerable energy reserves to create new growth that "seals" and surrounds a wound and then attempting to compensate structurally and physically for any losses. Impacts to trees are therefore cumulative and a series of otherwise small and unrelated impacts can easily result in the death of a tree.

A tree that is already compromised or showing signs of stress is far less likely to tolerate construction impacts due to its lower levels of energy reserves and already weakened state. Therefore, a tree that is only in a fair condition or poor condition is less likely to tolerate construction impacts than a young tree in good or excellent condition.

Weakened or stressed trees are also far less able to combat the myriad of normal environmental stresses and pathogens that are naturally imposed against them such as drought, decay, fungi, bacteria and insect pests.

2.6 Tree Impact Assessment

The intention of this assessment is to clearly illustrate the trees to be retained and removed as part of the development. It is also to determine any incursions into the retained trees' root zones and canopies by the proposed development and evaluate the likely impact of the proposed works on the trees. A detailed listing of the incursions and likely impacts of the proposed development on each tree is shown in Appendix 4.2 – Tree Impact Assessment Schedule and Appendix 4.1 – Tree Protection and Removal Plan.

Following is a summary and points arising from the tree impact assessment:

- **27** trees are identified to be **removed** due to being within the footprint of the works or being unacceptably impacted by the proposed works.
- Trees to be removed, by retention value are:
  - High – 6
  - Moderate – 10
  - Low – 11
- **7** trees (T26-T32) are identified to be **retained.** These trees are retained because they are largely outside the areas that will be directly impacted by the works.

Careful consideration was given to whether any of the trees proposed for removal could be worked around and retained but the likely impacts and the reasons for tree removal for those trees are outlined and listed below.

- Changes of the surface levels and the installation of permeable, or other paving, around the base of these established trees was highly likely to result in significant root damage. The levels around the bases of the trees was marginally above the levels that would be needed to tie into the proposed building floor levels and the levels of the street in Richmond Road. Some of the trees are particularly large trees and therefore have large nominal TPZ zones and the works could not be designed in a way that would have limited the incursion and impacts to a commonly acceptable limit, without substantially impacting the project outcomes.

- Many of the trees were very close to the proposed building structure itself. If the building was constructed as planned the trees would have experienced completely unacceptable impacts to their canopies and roots. This is particularly relevant when one considers the need for the construction period scaffold and access requirements to construct the building.
- There are numerous existing and proposed services that would need to be installed and removed in the area immediately south of the proposed building as this is the low side of the building. Trenching and installation of services in this zone would have further impacted and compromised the trees in this area.
- Most of the construction period access and construction material staging would be required to be undertaken from the TfNSW land south of the proposed building. It is highly likely that any trees retained in this area would have substantially inhibited machinery access, vehicle access and cranage options for the site.
- Finally, the retention of one or two of the larger trees in the area directly south of the proposed commuter carpark would have necessitated the retention of the existing ground level and soils and therefore prohibited the proper preparation of additonal planting areas for future replacement tree planting and other urban design and landscape outcomes.

In the authors opinion, and given the above constraints and potential excessive tree impacts, it was considered appropriate and preferrable to remove all the trees to the immediate south of the proposed commuter carpark to allow:-

- Appropriate construction period access and construction material handling, immediately adjacent to the proposed multi-storey building.
- Achievement of desirable and well-conceived resolution of levels and physical space for improved and accessible pedestrian and vehicular movements. These also need to marry appropriately to the relatively fixed levels of the adjoining streets, station infrastructure and proposed floor levels and access points of the multi-storey carpark.
- Proper and well considered preparation of suitable future tree planting areas for better longer term and appropriate new tree planting and facilitate the installation of more suitable soil volumes and drainage.
- Allow the planting of trees that can grow successfully in their new environment from the start rather that potentially impacting existing trees with conditions, such as overshadowing, that they have not grown under previously.
- Allow the unfettered and more cost-effective installation of major below ground services, in an area where services connections and extensive trenching was likely to be required.

Regarding the **7** trees that are to be retained and protected. Trees **T26-T32** are relatively small Australian native trees growing in a narrow garden bed on the southern boundary of the study area, between the station infrastructure to the south and an existing concrete pedestrian pathway to their north. A raised concrete kerb and the pathway separates these trees from the area expected to be impacted by the proposed works. Most of these trees are relatively small with nominal TPZs that don't extend beyond the northern edge of the existing concrete pathway. They are therefore expected to be retained without any impacts. One tree (**T30)** is a slightly larger *Melaleuca styphelioides* (Prickly Paperbark) and one tree (**T32)** is a small *Melaleuca quinquenervia* (Broad-leaf Paperbark) with nominal TPZs that extends beyond the northern edge of the existing concrete pathway. The levels expected to be required for the adjoining works and the pre-existing concrete pathway and kerbs means that the level of disturbance to these trees is expected to be minor. Disturbance within the nominal TPZ radius of these trees is expected to be largely related to the preparation of surface pavements only.

The proposed works may result in an 'incursion' of around 10% to **T30 and T32**. In the author's opinion there is a likelihood that root development to the north of the trees has been naturally inhibited. These species also have a recognised tolerance to root disturbances. They are therefore unlikely to experience any significant impacts from the proposed works, as long as the appropriate tree protection measures are implemented and adhered to throughout the course of the project. Refer to See Appendix 4.1, T-02 'Tree Protection & Removal Plan' for further details.

Importantly, tree protection fencing and trunk protection battens must be installed around these trees. The proposed demolition work of the existing concrete footpath is to be overseen by an AQF5 Consulting Arborist to ensure roots growing below or adjacent to the path are adequately protected. Levels and finishes around the trees are otherwise expected to remain largely unchanged.

Figure 8 – T26-T33 in garden bed adjacent the station building. Concrete kerb and path separate trees from the proposed works. Levels in this area are expected to largely stay as existing therefore these trees can be retained. (Source: Arterra 5/6/2022)

2.7 Potential Tree Related Impacts to be Managed During Construction

The main potential impacts from the proposed construction activity can be summarised as tree damage and 'reduced life expectancy' caused by:-

- Root loss and disturbance due to inappropriate excavation for the building, pathways and services;
- Compaction of the root zone from storage or stockpiling of materials;
- Contamination of the soil from the preparation of chemicals, wash down/ cleaning of equipment, refuelling of vehicles and dumping of waste;
- Compaction of the root zones from use of vehicles/ plant equipment;
- Root disturbances from unauthorised cut and fill and soil level changes;
- Physical damage to the tree trunks and branches from passing machinery;
- Damage to the tree roots from landscaping, services installation and pedestrian pathway construction.

The following Section of this report provides the recommendations and proposed measures that will aim to minimise and avoid these impacts as much as realistically possible.

3.0 TREE MANAGEMENT RECOMMENDATIONS

3.1 Key Recommendations to Reduce Tree Impacts

The following recommendations are made to potentially reduce the negative construction impacts on the existing trees identified to be retained.

- Ensure that all work within or immediately adjacent to the identified TPAs is carried out with care to limit surface impacts. If roots greater than 40mm Ø are encountered, works shall cease and direction sought from the project Consulting Arborist before proceeding further.
- Appropriately fence all TPAs outside of the already noted incursions for the duration of all major site construction work. See Appendix 4.1, T-02 'Tree Protection & Removal Plan' for locations and extent.
- Carefully control access to and from the active construction areas so that movement does not occur through any TPAs other than for the already identified building incursions.
- Ensure all the new above and below ground services are excluded from running through any TPAs beyond any already noted incursions.
- Minimise the re-grading of the ground surface within the identified TPAs, beyond the noted incursions, in order to meet and match proposed pathways and other building levels. Where it is required, limit filling to a maximum depth of 200mm above existing ground levels and ensure it is only quality sandy manufactured organic garden mix or other suitable site topsoils. No excavation below existing levels shall typically be allowed within the TPAs.
- Avoid digging into existing root zones for the installation of any proposed landscaping around the trees. The installation sizes of new plants within any TPAs is to be 5L (200mm) or less to ensure that excavations are less than 200mm in depth. It is recommended to build up soil levels for any new planting areas to a maximum of 200mm to enable the new planting to occur without disturbing existing tree roots.
- Do not allow storage or stockpiling of any materials or site sheds within established TPAs unless that it can be demonstrated that this will not impact on the tree retention and it is specifically approved in writing by the Project Consulting Arborist.

3.2 Proposed Tree Protection & Construction Activity Sequencing

The following sequence of activities should be followed for this project: -

1. A Tree Protection Specification & Plan is to be prepared and issued as part of the construction contract prior to any construction work.
2. The Project Consulting Arborist, Landscape Architect, Civil and Structural Engineers, Client and Contractor Site Foreman are to meet prior to the commencement of any work on the site to discuss and review all work procedures, construction access routes, stockpiling and tree protection measures (ie: fence types and locations, access, cranage points, piling methods etc.).
3. Contractor to discuss locations and type of any sediment and erosion controls (if any) and install them with minimal tree impact when within or passing through the TPA.
4. Existing pathways, fences, furniture, shrubs and lawn are to be carefully removed from within the TPAs as needed.
5. Existing surrounding trees are to be removed. Stumps are to be ground when near remaining trees to avoid the use of excavators and the like from grubbing out stumps, which may lead to damage of any intertwined roots.
6. The Construction Phase TPA is to be clearly defined and fenced off with a 1.8m high metal or plywood temporary fence prior to any further work within the vicinity of the trees as shown on T-02- Tree Protection and Removal Plan. Any required rumble boards/ ground protection shall be installed to protect TPAs areas where access is required or likely (none expected at this time).
7. No pruning is expected to be required. However, if pruning is required, it is to be undertaken by a utility Arborist only. This is to undertake selective pruning of canopy or branches without causing accidental damage to the remaining tree canopy. Pruning shall be done in accordance with AS4373 - Pruning of Amenity Trees and performed by staff with appropriate qualifications and equipment.
8. Plywood (or similar) is to be placed under any scaffolds or pedestrian works paths when they are running through any identified TPAs.
9. Building works are to be completed (all external works).
10. Contractor to then remove the TPA fencing and only then install final pathways, access driveways and landscaping within the TPAs under the trees, but only after construction of the main building exterior and all civil and structural landscape works are completed.

3.3 Demolition Work Near Trees or within TPAs

Demolition of paths and other structures required within a TPA shall be done with small tracked equipment or by hand, with care to limit surface damage and disturbance of the root zone.

3.4 Tree Protection Fencing & Definition of TPAs

Establish a clearly defined tree protection zone as indicated in Appendix 4.1 - "T-02 Tree Protection and Removal Plan". Install a 1.8m high temporary fence with either plywood hoarding or temporary steel mesh or chain wire fencing with adequate lateral bracing. Fencing shall comply with the requirements of AS 4687-2007 Temporary fencing and hoardings. These areas around the trees shall be delineated as a "Tree Protection Zone" during the remaining construction process, via appropriate weatherproof signage at not more than 30m spacing. Access will typically be excluded from these zones and the levels will be left largely at the existing levels. No stockpiling, excavation, trenching, re-fuelling or material storage shall be allowed in these areas.

3.5 Ground Protection within TPAs

Vehicular movement and access shall typically not be required or approved through the TPAs. If it is absolutely necessary and it is proposed to create any access, or similar, within the TPA of a retained tree, the Contractor shall install planks or boards over the designated TPA ground surface. No excavation shall be allowed. Contractor shall first place a suitable permeable geotextile to the extent required and then a 100mm thick layer of wood chip mulch or coarse no-fines gravel over the extent to be covered with the rumble strips or plywood boarding. Then place hardwood boards (minimum 3600 x 200 x 75mm) on their flat edge, side by side, with a 30 - 50mm gap to form a rumble strip. These boards are to be held together with galvanised metal bracing straps nailed/screwed to each board.

3.6 Final Landscaping within TPZs

Once final levels are set by the finished structural elements. The final trimming and landscaping shall be judiciously undertaken. The final pedestrian pavements shall be installed without undue excavation or compaction to the soil and all soft landscaping within the tree protection zone will be installed with care to avoid root disturbance via irrigation trenching, lighting installation and the planting of larger plants. The installation of 100-200mm of new garden mix topsoil over the pre-existing soil will provide a suitable medium in which to plant new plants without damage to existing tree roots. Permanent irrigation (if used) shall be installed as spray heads located outside of TPAs and spraying inwards. All other services such as electrical services shall also be designed and installed to avoid any excavation or trenching around the trees.

3.7 Final Building and Pedestrian Clearance Pruning

Once the final levels and finishes are in place the Project Consulting Arborist shall direct and supervise any remaining selective pruning of any lower peripheral branches to the retained trees to achieve any clearances for final pedestrian or building access. This shall be minimised as much as possible. It is anticipated that the final pruning of any of the retained trees will be less than 5% of the existing canopy and will not have any serious impact to the trees' health or habit.

The branches of the trees shall only be pruned as specifically needed and directed by the Project Consulting Arborist. Work is to be in strictly accordance with to AS4373 - Pruning of Amenity Trees. Do not treat wounds. Only clean, sharp pruning implements shall be used for all pruning work, ensuring that cuts are made without damage, tearing or bruising of the vascular tissue.

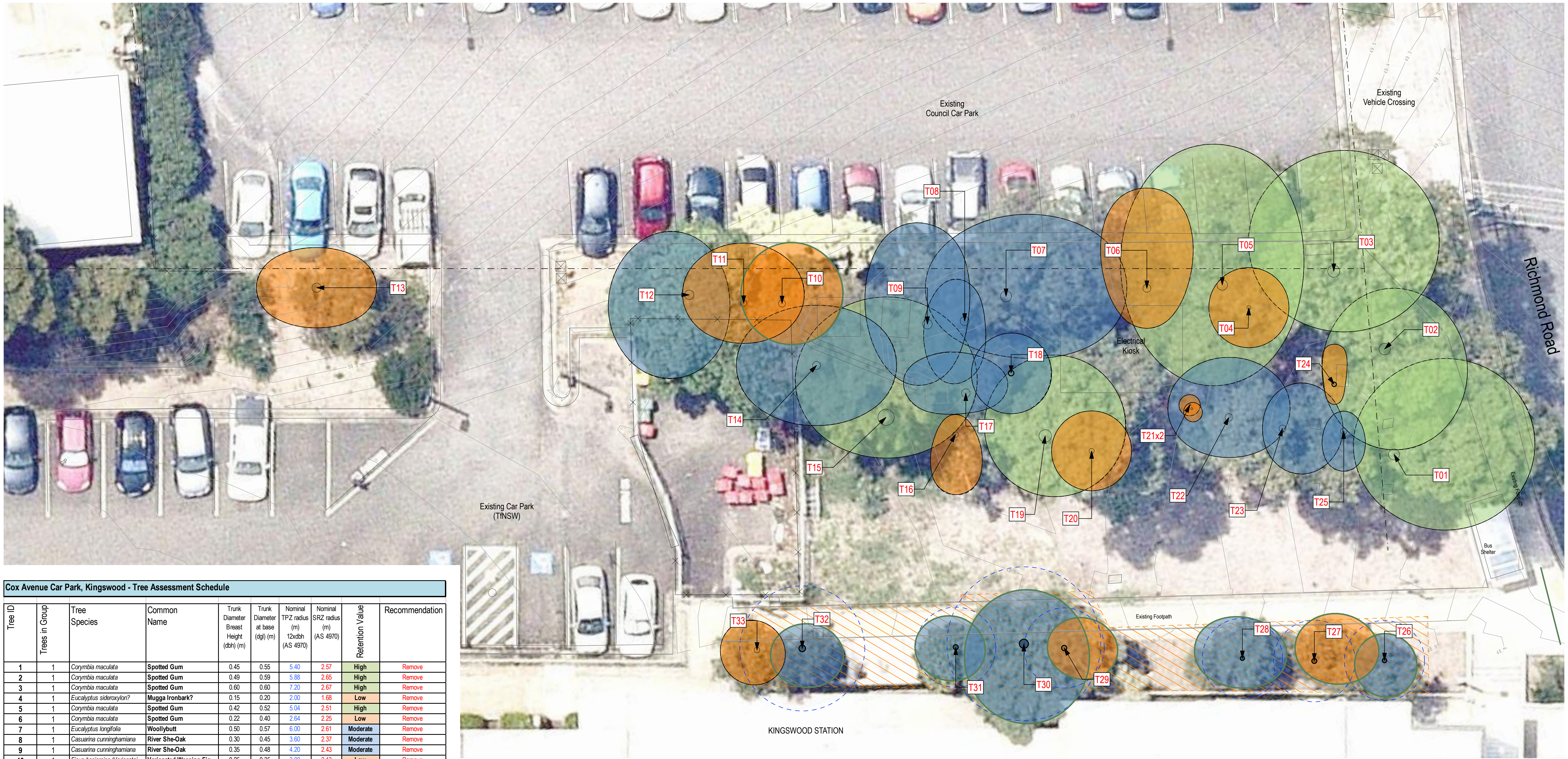
3.8 References

- Bannerman, S.M and Hazelton, P.A 1990, *Soil Landscapes of the Penrith 1:100 000 Sheet Report*, Soil Conservation Service of NSW, Sydney, NSW.
- Harris, R.W, Clark, J.R & Matheny, Nelda P, 1999*, Arboriculture: Integrated management of landscape trees, shrubs and vines*. 3rd Ed. Prentice Hall. New Jersey, US
- Matheny, Nelda P and Clark J.R, 1998, *Trees and development - a technical guide to preservation of trees during land development*, International Society of Arboriculture, Illinois, US.
- Roberts, J. Jackson, N. and Smith, M. 2006. *Tree roots in the built environment. No.8* Research for Amenity Trees, Dept. for Communities and Local Government, London.
- Standards Australia, 2007, *AS 4373-2007 Pruning of amenity trees*. Standards Australia, Sydney.
- Standards Australia, 2009, *AS 4970-2009 Protection of Trees on Development Sites*. Standards Australia, Sydney.
- Standards Australia, 2007, AS 4687-2007 *Temporary fencing and hoardings*. Standards Australia, Sydney.

- End of report.

4.0 APPENDICES

4.1 Tree Plans



Cox Avenue Car Park, Kingswood - Tree Assessment Schedule

Tree ID	Trees in Group	Tree Species	Common Name	Trunk Diameter Breast Height (dbh) (m)	Trunk Diameter at base (dgl) (m)	Nominal TPZ radius (m) 12xdbh (AS 4970)	Nominal SRZ radius (m) (AS 4970)	Retention Value	Recommendation
1	1	*Corymbia maculata*	**Spotted Gum**	0.45	0.55	5.40	2.57	**High**	Remove
2	1	*Corymbia maculata*	**Spotted Gum**	0.49	0.59	5.88	2.65	**High**	Remove
3	1	*Corymbia maculata*	**Spotted Gum**	0.60	0.60	7.20	2.67	**High**	Remove
4	1	*Eucalyptus sideroxylon?*	**Mugga Ironbark?**	0.15	0.20	2.00	1.68	**Low**	Remove
5	1	*Corymbia maculata*	**Spotted Gum**	0.42	0.52	5.04	2.51	**High**	Remove
6	1	*Corymbia maculata*	**Spotted Gum**	0.22	0.40	2.64	2.25	**Low**	Remove
7	1	*Eucalyptus longifolia*	**Woollybutt**	0.50	0.57	6.00	2.61	**Moderate**	Remove
8	1	*Casuarina cunninghamiana*	**River She-Oak**	0.30	0.45	3.60	2.37	**Moderate**	Remove
9	1	*Casuarina cunninghamiana*	**River She-Oak**	0.35	0.48	4.20	2.43	**Moderate**	Remove
10	1	*Ficus benjamina 'Variegata'*	**Variegated Weeping Fig**	0.25	0.35	3.00	2.13	**Low**	Remove
11	1	*Ficus benjamina 'Variegata'*	**Variegated Weeping Fig**	0.27	0.31	3.24	2.02	**Low**	Remove
12	1	*Lophostemon confertus*	**Brush Box**	0.39	0.47	4.68	2.41	**Moderate**	Remove
13	1	*Callistemon salignus cv.*	**Willow Bottlebrush**	0.25	0.46	3.00	2.39	**Low**	Remove
14	1	*Lophostemon confertus*	**Brush Box**	0.33	0.40	3.96	2.25	**Moderate**	Remove
15	1	*Casuarina cunninghamiana*	**River She-Oak**	0.53	0.81	6.36	3.03	**High**	Remove
16	1	*Melaleuca quinquenervia*	**Broad Leafed Paperbark**	0.20	0.28	2.40	1.94	**Low**	Remove
17	1	*Casuarina cunninghamiana*	**River She-Oak**	0.36	0.43	4.32	2.32	**Moderate**	Remove
18	1	*Lophostemon confertus*	**Brush Box**	0.20	0.27	2.40	1.91	**Moderate**	Remove
19	1	*Corymbia maculata*	**Spotted Gum**	0.47	0.62	5.64	2.71	**High**	Remove
20	1	*Corymbia maculata*	**Spotted Gum**	0.21	0.26	2.52	1.88	**Low**	Remove
21	2	*Casuarina glauca*	**Swamp She-Oak**	0.06	0.10	2.00	1.26	**Low**	Remove
22	1	*Corymbia maculata*	**Spotted Gum**	0.32	0.38	3.84	2.20	**Moderate**	Remove
23	1	*Melaleuca quinquenervia*	**Broad Leafed Paperbark**	0.26	0.35	3.12	2.13	**Moderate**	Remove
24	1	*Eucalyptus benthamii ??*	**Camden White Gum ??**	0.20	0.22	2.40	1.75	**Low**	Remove
25	1	*Corymbia maculata*	**Spotted Gum**	0.26	0.32	3.12	2.05	**Moderate**	Remove
26	1	*Callistemon citrinus cv.*	**Crimson Bottlebrush**	0.14	0.22	2.00	1.75	**Moderate**	Retain
27	1	*Callistemon viminalis cv.*	**Weeping Bottlebrush**	0.17	0.25	2.04	1.85	**Low**	Retain
28	1	*Callistemon viminalis cv.*	**Weeping Bottlebrush**	0.14	0.21	2.00	1.72	**Moderate**	Retain
29	1	*Melaleuca linariifolia*	**Flax Leaved Paperbark**	0.14	0.26	2.00	1.88	**Low**	Retain
30	1	*Melaleuca styphelioides*	**Prickly Paperbark**	0.32	0.45	3.84	2.37	**Moderate**	Retain
31	1	*Tristaniopsis laurina*	**Water Gum**	0.14	0.23	2.00	1.79	**Moderate**	Retain
32	1	*Melaleuca quinquenervia*	**Broad Leafed Paperbark**	0.26	0.37	3.12	2.18	**Moderate**	Retain
33	1	*Callistemon viminalis cv.*	**Weeping Bottlebrush**	0.22	0.28	2.64	1.94	**Low**	Remove

TREE RETENTION VALUE NOTES

The proposed retention value of the trees was determined based on a considered combination of the size, age, condition and suitability of the tree. Each tree was then ranked according to one of 4 retention categories;

1. **"High" Retention Value** — these are trees that are typically in good or very good condition, large and visually prominent, historically or environmentally important. They should represent a serious physical constraint to development and their removal avoided where possible and feasible.

2. **"Moderate" Retention Value** — these are trees that are in good to reasonable condition, with no major structural defects and could be retained where possible and feasible to do so.

3. **"Low" Retention Value** — these are trees that are of poor condition or have structural defects, are particularly small or common place, are not historically, environmentally or socially significant and should not be considered as a constraint to development. They could be retained only if they are not likely to be impacted by or constrain potentially desirable development outcomes.

4. **"Very Low" Retention Value** — these are trees that are in very poor health, or poor form, or have serious structural defects, are considered weeds or combination of all these, and therefore should be considered for removal regardless of any development.

Consideration has also been given to the relationship of the trees to one another and their proximity to the likely development areas on the site. For example, trees that are part of a closely spaced group, or are likely to be significantly misshapen or unstable with the removal of surrounding trees and structures are considered with these factors in mind.

NOTE

Refer to the accompanying Arboricultural Impact Assessment Report for full description of trees, measurements and methods used to assess the trees, and proposed tree protection measures.

Tree Retention Value Legend

Extent of canopy as verified by site measure and aerial photos

Nominal Tree Protection Zone (TPZ)

T26 Tree Identification Number

Proposed Tree Protection Area During Construction (TPA)

High Retention value

Moderate Retention value

Low Retention value
(Note: no TPZ's shown for these trees)

Very Low Retention value
(should remove)
(Note : no TPZ's shown for these trees)

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REVISION	DESCRIPTION	CHKD	DATE
B	For Information	RWS	09/06/22
A	For Information	RWS	05/02/21

PROJECT & CLIENT
Commuter Car Park - Kingswood
Penrith City Council

North

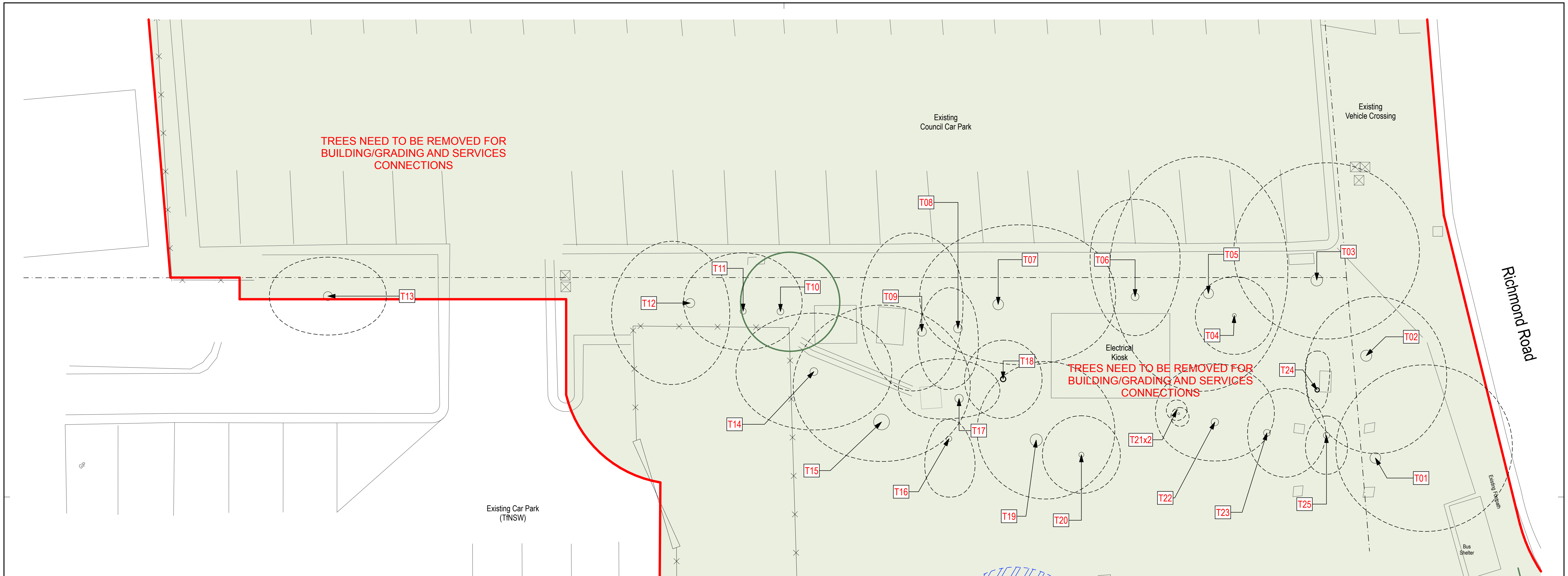
Project No : 21.03
Designed : RWS
Drawn : RWS
Scale : 1:100@A1/1:200@A3

DRAWING TITLE
Tree Retention Value Plan

DRAWING NUMBER
T-01

REVISION
B

Plotted at : 10:14 am 9/6/2022



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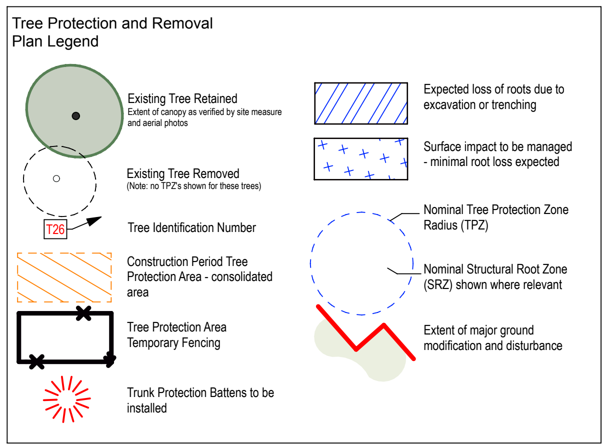

NOTE

Refer to the accompanying Arboricultural Impact Assessment Report for full description of trees, measurements and methods used to assess the trees, and proposed tree protection measures.

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REVISION	DESCRIPTION	CHKD	DATE
A	For REF Submission	RWS	09/06/22

PROJECT & CLIENT
Commuter Car Park - Kingswood
Penrith City Council

Project No : 21.03
Designed : RWS
Drawn : RWS
Scale : 1:100@A1/1:200@A3
North

DRAWING TITLE
Tree Protection and Removal Plan

DRAWING NUMBER T-02
REVISION A

Plotted at : 10:14 am 9/6/2022

TREE PROTECTION SPECIFICATIONS

1. Tree Protection Measures and Protocols.

All work around existing trees to be retained shall be in accordance with AS 4970-2009 Protection of trees on development sites with the clear establishment of the required Tree Protection Areas (TPA's). If the scope of work allowed within or the extent of the Tree Protection Areas of existing trees is not clear, please refer to the Contract Manager or Project Consulting Arborist for clarification.

Before any site works commence tree protection zones and other measures must be established and conveyed to those all working on the site. The Contractor shall ensure all subcontractors are inducted prior to working on the site. All inductions shall include description and identification of the Tree Protection Zones and the restriction on work and activities with regard to trees.

Damage to roots or degradation of the soil through compaction and/or excavation within TPA's is likely to cause serious damage to the tree. Any work operations required within TPA's must be carried out with extreme care. All trees, palms and other shrubs within TPA's are to be retained unless shown otherwise on the Tree Protection Plan(s). Trees marked for retention shall not be used to display signage, or as fence or cable supports for any reason. No materials stockpiling, chemicals or washout areas are permitted immediately upslope of or within the Tree Protection Area. The washing down of wheel barrows, paint cans/brushes, acids and the like shall not to be done near existing trees as the runoff is very harmful to tree roots.

No fuel powered pumps or generators or air compressors are to be placed within TPA's. No fuel or chemicals shall be stored and no equipment or vehicles shall be serviced or re-fuelled within a TPA.

2. Controlled Construction Access

Construction access points, stockpiling and storage areas shall be clearly identified on site and fenced off where appropriate. Uncontrolled access and parking of vehicles inside TPA's shall be avoided. If access is required through a tree protection area, the access way shall be treated with ground protection.

3. Tree Protection Fencing & Signage

The Tree Protection Plan(s) shows the extent of areas to be fenced and protected. Protection measures shall be certified as adequate by the Project Consulting Arborist. This fencing may form part of the general construction site fencing, where practical. It shall remain in place as long as possible and typically not be removed until the final landscape installation in those areas begins.

All tree protection fencing shall be 1800mm high galvanised chain wire or welded steel mesh. Fencing must be bolted together and secured with the necessary back stays and bracing.

Star pickets with bunting or danger tape shall not constitute acceptable tree protection fencing.

Suitable signage as defined by AS 4970-2009 Appendix C shall be affixed to the external side of the fencing at a spacing of not less than 1 sign per 20 lineal metres of fence.

If fence locations conflict with the proposed works, contact the Project Consulting Arborist and Contract Manager for resolution. No new services (unless under-bored) shall be located within or through the Tree Protection Area.

4. Trunk and Lower Branch Protection

A trunk barrier is to be erected around the circumference of the tree trunk and root buttress where shown. This barrier will consist of two to three 'rings' of 50mm diameter socked ag-line wrapped around tree trunk or branch and the ends cable tied to secure in place. A layer of battens is to be placed over and tight to the ag-lines. The battens are to have a maximum spacing of 50mm. The height of the battens is to be 2 metres or to the height of the first branches. Lower large branches may require the same protection if likely to be damaged by passing vehicles or equipment. Secure battens in place with galvanised steel bracing straps. Do not nail into or otherwise injure the trunk or bark. Battens may be made from any suitable waste timber of similar sizes and depths. All sharp or protruding edges are to be properly covered with tape or similar padding.

5. Works within the TPA's

All work within the root zone of existing trees shall be undertaken with the utmost care. If by necessity a tree requires removal of branches for building or access, pruning shall be done in strict accordance with accepted arboriculture techniques and AS 4373-2007. No rubbish, spoil or new materials shall be placed on the root zone of any existing tree or against their trunks.

6. Ground Protection

If it is proposed to create any access route, or similar, within the TPA of a retained tree, the Contractor shall install rumble boards over the TPA ground surface. No excavation shall be allowed. Contractor shall first place a suitable permeable geotextile to the extent required and then a 100mm thick layer of wood chip mulch or coarse no-fines gravel over the extent to be covered. Then place hardwood boards (minimum 3600 x 200 x 75mm) on their flat edge, side by side, with a 30 - 50mm gap to form a rumble strip. These boards are to be held together with three galvanised metal bracing straps nailed to each board. The two outer straps are to be approximately 200mm in from the ends of the boards. The third strap is to be along the centre line of the boards.

7. Provision of Temporary Irrigation

Not required for this project.

8. Structural Demolition Within TPA's

Project Consulting Arborist shall be on site during all demolition work within the TPA's to monitor and advise on tree protection. Secateurs and a handsaw shall be available to deal with and cleanly cut any exposed roots that have to be cut. Machines with a long reach may be used if they can work from outside TPA's or from protected areas within TPA's. They shall not encroach onto unprotected soil in TPA's.

Debris to be removed from TPA's must be moved across existing hard surfacing or temporary ground protection in a way that prevents compaction and disturbance of soil. Alternatively, it can be lifted out by machines provided this does not disturb TPA's or damage the canopy. If appropriate, leave below ground structures such as footings and disused pipes in place if their removal will cause excessive root disturbance.

When pulling up existing paving the Contractor shall work backwards, lifting demolished paving back onto the existing paving. Roots may be found growing under the pavement and should not be trafficked. Roots growing into existing sub-base should be left and new surface finishes placed over the top without disturbance.

9. Excavations or Trenching within TPA's

Excavation within TPA's shall not be allowed using mechanical equipment such as excavators or backhoes. Excavation within TPA's shall only be carried out carefully by hand taking care not to damage the bark and wood of any roots. Specialist tools for removing soil around roots using compressed air (air spade), or water vacuum extraction shall be an appropriate alternative to hand digging and is the preferred method.

Exposed roots to be removed shall be cut cleanly with a sharp saw or secateurs at the face of the excavation. Roots temporarily exposed must be protected by appropriate covering with damp hessian or sand. Roots greater than 50mm in diameter are to be retained and shall only be cut in exceptional circumstances and only after consultation with the Project Consulting Arborist. Roots greater than 100mm in diameter shall typically not be allowed to be cut and must be worked around.

10. Soft Landscaping Installation

Final trimming and planting shall be judiciously undertaken around trees. All soft landscaping within the tree protection zones will be installed with care to avoid root disturbance from irrigation trenching, lighting installation and the planting of larger plants. Permanent irrigation (if used) shall be installed as spray heads located outside of TPA's and spraying inwards. All other services such as small-scale electrical services shall also be designed and installed to avoid any excavation or trenching around the trees.

No significant excavation or cultivation, especially by rotary hoes or excavators, shall occur within TPA's. Where new designs require the levels to be increased, good quality and permeable top soil shall be used. It should be firmed into place but not over compacted. All areas close to tree trunks shall be kept at the original ground level. Where turf is to be installed tree trunks shall have mulched rings applied rather than grass laid up to the trunk.

The size of the installed plants shall typically be less than 5L pots so that the maximum depth of the new root balls is less than 200mm. Any planting proposed that is larger than this shall be only installed outside of the SRZ and with care to not injure roots while digging planting holes.

11. Canopy Pruning

The Contractor shall prune branches of protected trees only as directed by the Project Consulting Arborist. Pruning is only to be undertaken by a qualified arborist (under the supervision of a person with AQF Level 4 or above). The Project Consulting Arborist is to be present at all times during the pruning work. Work is to be in strict accordance with AS4373 Pruning of Amenity Trees. Do not treat wounds.

12. Root Pruning

Pruning of roots of protected trees shall only be as directed the Project Consulting Arborist. The Tree Contractor shall use only a qualified arborist (AQF Level 4 or above). The Project Consulting Arborist is to be present at all times during the root pruning.

Roots are not to be cut using normal excavation machinery of any sort. This usually results in splitting and massive disturbance well past the intended line of cut. When required to cut roots, use hand methods and sharp hand tools (e.g. secateurs, hand saw) such that the remaining root systems are preserved intact and undamaged. Roots are to be cut back by hand square to the direction of the root travel (or edge of the excavation). Do not cut any tree roots exceeding 40mm diameter unless permitted. Excavations within root zones should be kept open for as short a period as possible. Any excavated face containing roots is to be temporarily supported, where necessary, to prevent soil loss from around the other retained roots.

13. Accidental Tree Damage

Should a tree be accidentally damaged, the Contractor shall immediately notify the Project Consulting Arborist. Timing can be of the essence, particularly with bark injuries, trunk damage or chemical contaminations.

If a branch has been broken, it shall be removed and the damaged end pruned to a suitable branch collar. If the branch has been torn out of the trunk, assessment shall be made and the damage cleaned up by as much as possible without further damage to the tree.

If roots are accidentally disturbed or excavated, any broken, crushed and torn sections shall be exposed and pruned leaving clean cuts to minimise risk of infection by fungal pathogens and promote good conditions for new root growth.

Example image of acceptable tree protection fencing measures to be applied. (1.8m high rigid metal fencing with appropriate lateral bracing)

Example image of acceptable tree tree protection battens

Example image of acceptable ground protection rumble boards

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REVISION	DESCRIPTION	CHKD	DATE
A	For REF Submission	RWS	09/06/22

PROJECT & CLIENT
Commuter Car Park - Kingswood
Penrith City Council

North

Project No : 21.03
Designed : RWS
Drawn : RWS
Scale : N/A

DRAWING TITLE
Tree Protection Specifications

DRAWING NUMBER T-03

REVISION A

Plotted at : 10:14 am 9/6/2022

4.2 Tree Impact Assessment Schedule

Cox Avenue Car Park, Kingswood - Tree Assessment Schedule

Tree ID	Trees in Group	Tree Species	Common Name	Height (m)	Spread North (m)	Spread West (m)	Spread South (m)	Spread East (m)	Trunk Diameter Breast Height (dbh) (m)	Trunk Diameter at base (dgl) (m)	Nominal TPZ radius (m) 12xdbh (AS 4970)	Nominal SRZ radius (m) (AS 4970)	Age Class	Current Vigour	Current Form	Noted Defects	SULE Rating	Retention Value	General Comments and Notes	Incursion and Impact	Recommendation
1	1	*Corymbia maculata*	**Spotted Gum**	22.0	4.0	2.0	3.0	7.0	0.45	0.55	5.40	2.57	Mature	Good	Average		Long (>40 years)	**High**		Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
2	1	*Corymbia maculata*	**Spotted Gum**	22.0	3.0	3.0	5.0	4.0	0.49	0.59	5.88	2.65	Mature	Good	Average	Inclusions, Co-dominant Stems	Long (>40 years)	**High**		Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
3	1	*Corymbia maculata*	**Spotted Gum**	25.0	6.0	4.0	3.0	5.0	0.60	0.60	7.20	2.67	Mature	Good	Average		Long (>40 years)	**High**	Spiral wounding up trunk now largely occluded. Likely from historic lightning strike. Large root visible extending to and under footpath.	Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
4	1	*Eucalyptus sideroxylon?*	**Mugga Ironbark?**	8.0	2.0	2.0	2.0	2.0	0.15	0.20	2.00	1.68	Mature	Poor	Poor	Deadwood-Major, Very Asymmetric Form, Tip Dieback, Epicormic Growth	Medium (15-40 years)	**Low**	Generally poor condition and form. Basal wounding/ mechanical damage to east. Not enough identification material to make conclusive species ID.	Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
5	1	*Corymbia maculata*	**Spotted Gum**	23.5	7.0	5.0	5.0	4.0	0.42	0.52	5.04	2.51	Mature	Good	Average		Long (>40 years)	**High**		Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
6	1	*Corymbia maculata*	**Spotted Gum**	10.0	5.0	2.0	2.0	2.0	0.22	0.40	2.64	2.25	Mature	Good	Average	Co-dominant Stems, Inclusions, Epicormic Growth, Tip Dieback, Termites	Medium (15-40 years)	**Low**	Previously failed tree at the base. Now re-sprouting from the remnant stump at the base. Poor form and trunk attachments. Evidence of previous termite mudding. No active termites observed.	Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
7	1	*Eucalyptus longifolia*	**Woollybutt**	20.5	4.0	4.0	3.0	6.0	0.50	0.57	6.00	2.61	Mature	Good	Average	Co-dominant Stems, Inclusions, Tip Dieback, Epicormic Growth	Long (>40 years)	**Moderate**	Dieback and suppressed foliage on southern side. Base surrounded by invasive weed species - Olive and Privet. Surrounding weeds should be removed and treated.	Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
8	1	*Casuarina cunninghamiana*	**River She-Oak**	20.5	2.0	2.0	3.0	1.0	0.30	0.45	3.60	2.37	Mature	Fair	Average	Very Asymmetric Form, Epicormic Growth	Long (>40 years)	**Moderate**		Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
9	1	*Casuarina cunninghamiana*	**River She-Oak**	18.0	5.0	3.0	3.0	2.0	0.35	0.48	4.20	2.43	Mature	Fair	Average	Very Asymmetric Form	Long (>40 years)	**Moderate**		Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
10	1	*Ficus benjamina 'Variegata'*	**Variegated Weeping Fig**	7.5	3.0	2.0	2.0	3.0	0.25	0.35	3.00	2.13	Semi-mature	Good	Poor	Very Asymmetric Form	Long (>40 years)	**Low**	Intergrown canopy with adjoining tree.	Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
11	1	*Ficus benjamina 'Variegata'*	**Variegated Weeping Fig**	8.0	3.0	3.0	2.0	3.0	0.27	0.31	3.24	2.02	Semi-mature	Good	Poor	Epicormic Growth, Very Asymmetric Form	Long (>40 years)	**Low**	Intergrown canopy with adjoining tree	Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
12	1	*Lophostemon confertus*	**Brush Box**	11.0	3.0	4.0	4.0	2.0	0.39	0.47	4.68	2.41	Mature	Good	Poor	Co-dominant Stems, Inclusions, Very Asymmetric Form	Long (>40 years)	**Moderate**	Inter grown canopy with adjoining tree. Tridominant trunks from base and included.	Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
13	1	*Callistemon salignus cv.*	**Willow Bottlebrush**	7.5	2.0	3.0	2.0	3.0	0.25	0.46	3.00	2.39	Mature	Fair	Poor	Co-dominant Stems, Tip Dieback, Epicormic Growth, Branch Tearouts	Long (>40 years)	**Low**	Pruned for CCTV clearance. Significant wound from large branch tearout to eastern side.	Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
14	1	*Lophostemon confertus*	**Brush Box**	12.0	3.0	4.0	3.0	4.0	0.33	0.40	3.96	2.25	Mature	Fair	Average	Very Asymmetric Form, Lean-Minor	Long (>40 years)	**Moderate**		Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
15	1	*Casuarina cunninghamiana*	**River She-Oak**	18.0	6.0	4.0	2.0	4.0	0.53	0.81	6.36	3.03	Mature	Good	Average	Very Asymmetric Form	Long (>40 years)	**High**	Pruned for clearances from powerlines on southern side	Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
16	1	*Melaleuca quinquenervia*	**Broad Leafed Paperbark**	9.5	1.0	1.0	3.0	1.0	0.20	0.28	2.40	1.94	Mature	Fair	Poor	Very Asymmetric Form	Long (>40 years)	**Low**	Generally poor form and minimal foliage.	Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
17	1	*Casuarina cunninghamiana*	**River She-Oak**	18.0	2.0	3.0	1.0	2.0	0.36	0.43	4.32	2.32	Mature	Fair	Average	Deadwood-Minor	Long (>40 years)	**Moderate**		Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
18	1	*Lophostemon confertus*	**Brush Box**	10.5	2.0	2.0	2.0	2.0	0.20	0.27	2.40	1.91	Mature	Fair	Average	Very Asymmetric Form, Lean-Minor	Long (>40 years)	**Moderate**		Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
19	1	*Corymbia maculata*	**Spotted Gum**	22.0	4.0	3.0	3.0	4.0	0.47	0.62	5.64	2.71	Mature	Good	Average		Long (>40 years)	**High**	Pruned for powerline clearances on southern side.	Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
20	1	*Corymbia maculata*	**Spotted Gum**	9.0	2.0	2.0	2.0	2.0	0.21	0.26	2.52	1.88	Mature	Good	Poor	Branch Tearouts, Epicormic Growth	Long (>40 years)	**Low**	Previous central leader broken and now pruned out.	Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
21	2	*Casuarina glauca*	**Swamp She-Oak**	6.0	0.5	0.5	0.5	0.5	0.06	0.10	2.00	1.26	Young	Good	Suppressed	Poor Taper	Long (>40 years)	**Low**	Two closely spaced, assumed self sown specimens growing together.	Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
22	1	*Corymbia maculata*	**Spotted Gum**	22.0	3.0	3.0	2.0	3.0	0.32	0.38	3.84	2.20	Mature	Good	Average		Long (>40 years)	**Moderate**		Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
23	1	*Melaleuca quinquenervia*	**Broad Leafed Paperbark**	11.0	2.0	1.0	2.0	3.0	0.26	0.35	3.12	2.13	Mature	Fair	Average		Long (>40 years)	**Moderate**		Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
24	1	*Eucalyptus benthamii ??*	**Camden White Gum ??**	13.0	2.0	0.5	1.0	0.5	0.20	0.22	2.40	1.75	Semi-mature	Poor	Suppressed	Major Wounding, Branch Tearouts, Deadwood-Minor, Poor Taper	Medium (15-40 years)	**Low**	Kinked trunk at 1.5m and previous major branch tear out. Minimal and sparse foliage, very suppressed form. Not enough identification material to make conclusive species ID.	Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
25	1	*Corymbia maculata*	**Spotted Gum**	20.0	1.0	1.0	2.0	1.0	0.26	0.32	3.12	2.05	Mature	Good	Average		Long (>40 years)	**Moderate**		Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove
26	1	*Callistemon citrinus cv.*	**Crimson Bottlebrush**	7.0	1.5	1.5	1.5	1.5	0.14	0.22	2.00	1.75	Mature	Good	Average	Major Wounding	Medium (15-40 years)	**Moderate**		No impact expected. Garden area proposed to be retained and protected	Retain
27	1	*Callistemon viminalis cv.*	**Weeping Bottlebrush**	7.0	3.0	0.5	1.0	2.5	0.17	0.25	2.04	1.85	Mature	Good	Average	Lean-Minor, Very Asymmetric Form	Medium (15-40 years)	**Low**	Minor lean to north-east.	No impact expected. Garden area proposed to be retained and protected	Retain
28	1	*Callistemon viminalis cv.*	**Weeping Bottlebrush**	7.0	2.0	2.0	1.5	2.5	0.14	0.21	2.00	1.72	Mature	Good	Average		Medium (15-40 years)	**Moderate**		No impact expected. Garden area proposed to be retained and protected	Retain
29	1	*Melaleuca linariifolia*	**Flax Leaved Paperbark**	5.5	1.5	0.5	1.0	2.0	0.14	0.26	2.00	1.88	Mature	Poor	Poor	Tip Dieback, Very Asymmetric Form, Epicormic Growth	Short (5-15 years)	**Low**	Suppressed by larger tree to west.	No impact expected. Garden area proposed to be retained and protected	Retain
30	1	*Melaleuca styphelioides*	**Prickly Paperbark**	8.0	2.0	2.0	2.5	2.0	0.32	0.45	3.84	2.37	Mature	Good	Average		Medium (15-40 years)	**Moderate**		10% incursion due to potential grading and earthworks to the northern side. Surface impacts due to demoltion to be managed. Garden area proposed to be retained and protected.	Retain
31	1	*Tristaniopsis laurina*	**Water Gum**	7.0	1.5	1.5	1.5	1.5	0.14	0.23	2.00	1.79	Mature	Good	Average		Medium (15-40 years)	**Moderate**		Minor incursion only. Garden area proposed to be retained and protected. Surface impact due to demolition to be managed.	Retain
32	1	*Melaleuca quinquenervia*	**Broad Leafed Paperbark**	8.0	1.5	2.0	1.5	1.5	0.26	0.37	3.12	2.18	Mature	Good	Average		Medium (15-40 years)	**Moderate**		10% incursion due to potential grading and earthworks to the northern side. Surface impacts due to demoltion to be managed. Garden area proposed to be retained and protected.	Retain
33	1	*Callistemon viminalis cv.*	**Weeping Bottlebrush**	8.0	1.5	2.0	2.0	1.0	0.22	0.28	2.64	1.94	Mature	Fair	Average		Medium (15-40 years)	**Low**		Within footprint of proposed works and grading. Impacts considered too great to successfully retain tree.	Remove

4.3 Tree Data Summary Sheets

ID # **01**

Species: Corymbia maculata
Common: Spotted Gum
Height: 22.0
DBH: 0.45 DGL: 0.55
TPZ: 5.4 SRZ: 2.57
Current Form: Average
Current Vigour: Good
Age Class: Mature
SULE: Long (>40 years)
Retention Value: **High**

Comments

ID # **04**

Species: Eucalyptus sideroxylon?
Common: Mugga Ironbark
Height: 8.0
DBH: 0.15 DGL: 0.20
TPZ: 2 SRZ: 1.68
Current Form: Poor
Current Vigour: Poor
Age Class: Mature
SULE: Medium (15-40 years)
Retention Value: **Low**

Comments

Generally poor condition and form. Basal wounding/ mechanical damage to east.

ID # **02**

Species: Corymbia maculata
Common: Spotted Gum
Height: 22.0
DBH: 0.49 DGL: 0.59
TPZ: 5.88 SRZ: 2.65
Current Form: Average
Current Vigour: Good
Age Class: Mature
SULE: Long (>40 years)
Retention Value: **High**

Comments

ID # **05**

Species: Corymbia maculata
Common: Spotted Gum
Height: 23.5
DBH: 0.42 DGL: 0.52
TPZ: 5.04 SRZ: 2.51
Current Form: Average
Current Vigour: Good
Age Class: Mature
SULE: Long (>40 years)
Retention Value: **High**

Comments

ID # **03**

Species: Corymbia maculata
Common: Spotted Gum
Height: 25.0
DBH: 0.60 DGL: 0.60
TPZ: 7.2 SRZ: 2.67
Current Form: Average
Current Vigour: Good
Age Class: Mature
SULE: Long (>40 years)
Retention Value: **High**

Comments

Spiral wounding up trunk now largely occluded. Likely from historic lightning strike. Large root visible extending to and under footpath.

ID # **06**

Species: Corymbia maculata
Common: Spotted Gum
Height: 10.0
DBH: 0.22 DGL: 0.40
TPZ: 2.64 SRZ: 2.25
Current Form: Average
Current Vigour: Good
Age Class: Mature
SULE: Medium (15-40 years)
Retention Value: **Low**

Comments

Previously failed tree at the base. Now re-sprouting from the remnant stump at the base. Poor form and trunk attachments. Evidence of previous termite mudding. No active termites observed.

ID # **07**

Species: Eucalyptus longifolia

Common: Woollybutt

Height: 20.5

DBH: 0.50 DGL: 0.57
TPZ: 6 SRZ: 2.61

Current Form: Average

Current Vigour: Good

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **Moderate**

Comments

Dieback and suppressed foliage on southern side. Base surrounded by invasive weed species - Olive and Privet. Surrounding weeds should be removed and treated.

ID # **08**

Species: Casuarina cunninghamiana

Common: River She-Oak

Height: 20.5

DBH: 0.30 DGL: 0.45
TPZ: 3.6 SRZ: 2.37

Current Form: Average

Current Vigour: Fair

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **Moderate**

Comments

ID # **09**

Species: Casuarina cunninghamiana

Common: River She-Oak

Height: 18.0

DBH: 0.35 DGL: 0.48
TPZ: 4.2 SRZ: 2.43

Current Form: Average

Current Vigour: Fair

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **Moderate**

Comments

ID # **10**

Species: Ficus benjamina 'Variegata'

Common: Variegated Weeping Fig

Height: 7.5

DBH: 0.25 DGL: 0.35
TPZ: 3 SRZ: 2.13

Current Form: Poor

Current Vigour: Good

Age Class: Semi-mature

SULE: Long (>40 years)

Retention Value: **Low**

Comments

Intergrown canopy with adjoining tree.

ID # **11**

Species: Ficus benjamina 'Variegata'

Common: Variegated Weeping Fig

Height: 8.0

DBH: 0.27 DGL: 0.31
TPZ: 3.24 SRZ: 2.02

Current Form: Poor

Current Vigour: Good

Age Class: Semi-mature

SULE: Long (>40 years)

Retention Value: **Low**

Comments

Intergrown canopy with adjoining tree

ID # **12**

Species: Lophostemon confertus

Common: Brush Box

Height: 11.0

DBH: 0.39 DGL: 0.47
TPZ: 4.68 SRZ: 2.41

Current Form: Poor

Current Vigour: Good

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **Moderate**

Comments

Inter grown canopy with adjoining tree. Tridominant trunks from base and included.

ID # **13**

Species: Callistemon salignus cv.

Common: Willow Bottlebrush

Height: 7.5

DBH: 0..25 DGL: 0.46

TPZ: 3 SRZ: 2.39

Current Form: Poor

Current Vigour: Fair

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **Low**

Comments

Pruned for CCTV clearance. Significant wound from large branch tearout to eastern side.

ID # **14**

Species: Lophostemon confertus

Common: Brush Box

Height: 12.0

DBH: 0.33 DGL: 0.40

TPZ: 3.96 SRZ: 2.25

Current Form: Average

Current Vigour: Fair

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **Moderate**

Comments

ID # **15**

Species: Casuarina cunninghamiana

Common: River She-Oak

Height: 18.0

DBH: 0.53 DGL: 0.81

TPZ: 6.36 SRZ: 3.03

Current Form: Average

Current Vigour: Good

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **High**

Comments

Pruned for clearances from powerlines on southern side

ID # **16**

Species: Melaleuca quinquenervia

Common: Broad Leafed Paperbark

Height: 9.5

DBH: 0.20 DGL: 0.28

TPZ: 2.4 SRZ: 1.94

Current Form: Poor

Current Vigour: Fair

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **Low**

Comments

Generally poor form and minimal foliage.

ID # **17**

Species: Casuarina cunninghamiana

Common: River She-Oak

Height: 18.0

DBH: 0.36 DGL: 0.43

TPZ: 4.32 SRZ: 2.32

Current Form: Average

Current Vigour: Fair

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **Moderate**

Comments

ID # **18**

Species: Lophostemon confertus

Common: Brush Box

Height: 10.5

DBH: 0.20 DGL: 0.27

TPZ: 2.4 SRZ: 1.91

Current Form: Average

Current Vigour: Fair

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **Moderate**

Comments

ID # **19**

Species: Corymbia maculata

Common: Spotted Gum

Height: 22.0

DBH: 0.47 DGL: 0.62
TPZ: 5.64 SRZ: 2.71

Current Form: Average

Current Vigour: Good

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **High**

Comments

Pruned for powerline clearances on southern side.

ID # **20**

Species: Corymbia maculata

Common: Spotted Gum

Height: 9.0

DBH: 0.21 DGL: 0.26
TPZ: 2.52 SRZ: 1.88

Current Form: Poor

Current Vigour: Good

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **Low**

Comments

Previous central leader broken and now pruned out.

ID # **21**

Species: Casuarina glauca

Common: Swamp She-Oak

Height: 6.0

DBH: 0.06 DGL: 0.10
TPZ: 2 SRZ: 1.5

Current Form: Suppressed

Current Vigour: Good

Age Class: Young

SULE: Long (>40 years)

Retention Value: **Low**

Comments

Two closely spaced, assumed self sown specimens growing together.

ID # **22**

Species: Corymbia maculata

Common: Spotted Gum

Height: 22.0

DBH: 0.32 DGL: 0.38
TPZ: 3.84 SRZ: 2.2

Current Form: Average

Current Vigour: Good

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **Moderate**

Comments

ID # **23**

Species: Melaleuca quinquenervia

Common: Broad Leafed Paperbark

Height: 11.0

DBH: 0.26 DGL: 0.35
TPZ: 3.12 SRZ: 2.13

Current Form: Average

Current Vigour: Fair

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **Moderate**

Comments

ID # **24**

Species: Euc sp.

Common: Gum

Height: 13.0

DBH: 0.20 DGL: 0.22
TPZ: 2.4 SRZ: 1.75

Current Form: Suppressed

Current Vigour: Poor

Age Class: Semi-mature

SULE: Medium (15-40 years)

Retention Value: **Low**

Comments

Kinked trunk at 1.5m and previous major branch tear out. Minimal and sparse foliage, very suppressed form.

ID # **25**

Species: Corymbia maculata

Common: Spotted Gum

Height: 20.0

DBH: 0.26 DGL: 0.32
TPZ: 3.12 SRZ: 2.05

Current Form: Average

Current Vigour: Good

Age Class: Mature

SULE: Long (>40 years)

Retention Value: **Moderate**

Comments

ID # **28**

Species: Callistemon viminalis cv.

Common: Weeping Bottlebrush

Height: 7.0

DBH: 0.14 DGL: 0.21
TPZ: 2 SRZ: 1.72

Current Form: Average

Current Vigour: Good

Age Class: Mature

SULE: Medium (15-40 years)

Retention Value: **Moderate**

Comments

ID # **26**

Species: Callistemon citrinus cv.

Common: Crimson Bottlebrush

Height: 7.0

DBH: 0.14 DGL: 0.22
TPZ: 2 SRZ: 1.75

Current Form: Average

Current Vigour: Good

Age Class: Mature

SULE: Medium (15-40 years)

Retention Value: **Moderate**

Comments

ID # **29**

Species: Melaleuca linariifolia

Common: Flax Leaved Paperbark

Height: 5.50

DBH: 0.14 DGL: 0.26
TPZ: 2 SRZ: 1.88

Current Form: Poor

Current Vigour: Poor

Age Class: Mature

SULE: Short (5-15 years)

Retention Value: **Low**

Comments

Suppressed by larger tree to west.

ID # **27**

Species: Callistemon viminalis cv.

Common: Weeping Bottlebrush

Height: 7.0

DBH: 0.17 DGL: 0.25
TPZ: 2.04 SRZ: 1.85

Current Form: Average

Current Vigour: Good

Age Class: Mature

SULE: Medium (15-40 years)

Retention Value: **Low**

Comments

Minor lean to north-east.

ID # **30**

Species: Melaleuca styphelioides

Common: Prickly Paperbark

Height: 8.0

DBH: 0.32 DGL: 0.45
TPZ: 3.84 SRZ: 2.37

Current Form: Average

Current Vigour: Good

Age Class: Mature

SULE: Medium (15-40 years)

Retention Value: **Moderate**

Comments

ID # **31**

Species: Tristaniopsis laurina

Common: Water Gum

Height: 7.0

DBH: 0.14 DGL: 0.23
TPZ: 2 SRZ: 1.79

Current Form: Average

Current Vigour: Good

Age Class: Mature

SULE: Medium (15-40 years)

Retention Value: **Moderate**

Comments

ID # **32**

Species: Melaleuca quinquenervia

Common: Broad Leafed Paperbark

Height: 8.0

DBH: 0.26 DGL: 0.37
TPZ: 3.12 SRZ: 2.18

Current Form: Average

Current Vigour: Good

Age Class: Mature

SULE: Medium (15-40 years)

Retention Value: **Moderate**

Comments

ID # **33**

Species: Callistemon viminalis cv.

Common: Weeping Bottlebrush

Height: 8.0

DBH: 0.22 DGL: 0.28
TPZ: 2.64 SRZ: 1.94

Current Form: Average

Current Vigour: Fair

Age Class: Mature

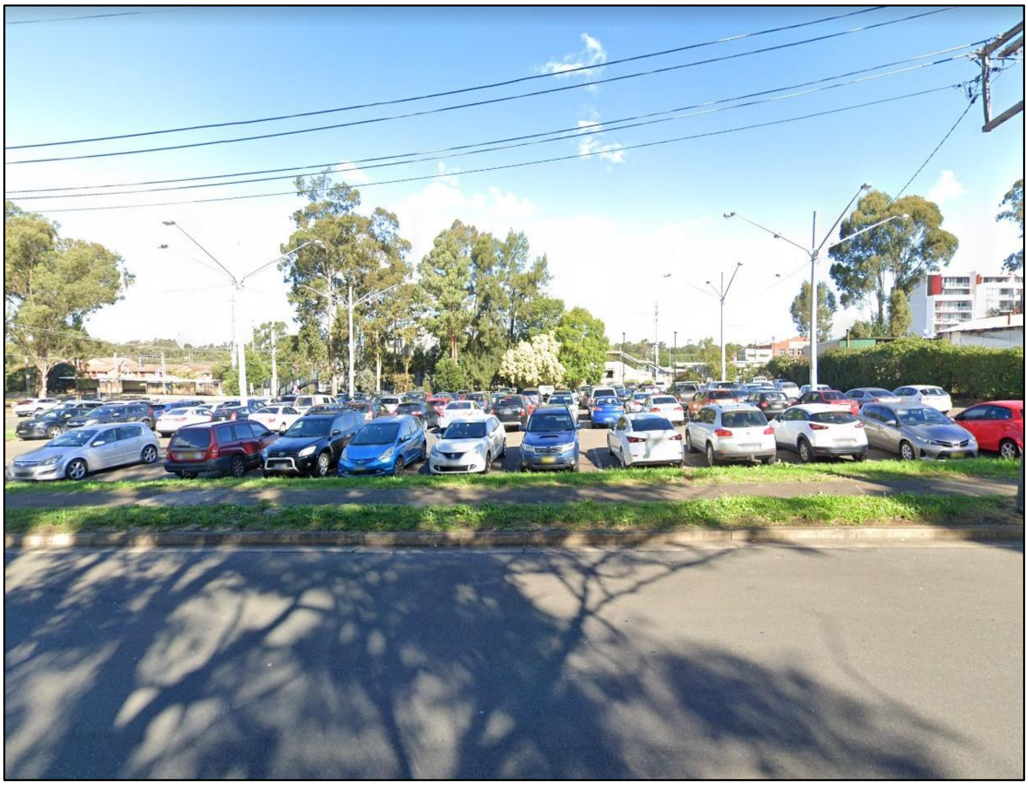
SULE: Medium (15-40 years)

Retention Value: **Low**

Comments

Appendix I

Heritage assessment



Street view image of the study area.

ABORIGINAL DUE DILIGENCE & HISTORIC HERITAGE DESKTOP ASSESSMENT REPORT

KINGSWOOD COMMUTER CAR PARK PROJECT

PENRITH, NSW

JULY 2022

Report prepared by

OzArk Environment & Heritage

for WSP on behalf of Penrith City Council

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Acknowledgement

OzArk acknowledge Traditional Owners of the area on which this assessment took place and pay respect to their beliefs, cultural heritage and continuing connection with the land. We also acknowledge and pay respect to the post-contact experiences of Aboriginal people with attachment to the area and to the elders, past and present, as the next generation of role models and vessels for memories, traditions, culture and hopes of local Aboriginal people.

Executive Summary

OzArk Environment and Heritage (OzArk) has been engaged by WSP Australia Pty Limited on behalf of Penrith City Council (PCC) to complete an Aboriginal and Historic Heritage Due Diligence archaeological assessment for Kingswood Commuter Car Park Project at 6 Cox Avenue (Lot 1 DP198211), Kingswood NSW (the project). The project is within the Penrith City Council Local Government Area.

This assessment was completed at a desktop level and did not involve a visual inspection.

The study area for the project is approximately 3.6 kilometres (km) to the east of the Nepean River and 745 metres (m) to the east of the Parker Street, Richmond Road, and the Great Western Motorway intersection.

<u>Aboriginal cultural heritage</u>

A search of the Aboriginal Heritage Information Management System (AHIMS) returned no Aboriginal sites within the study area.

The undertaking of the due diligence process resulted in the conclusion that the proposed works will have an impact on the ground surface, however, no Aboriginal objects or intact archaeological deposits will be harmed by the project. This moves the project to the following outcome:

> *AHIP application not necessary. Proceed with caution. If any Aboriginal objects are found, stop work, and notify Heritage NSW (02) 9873 8500 (heritagemailbox @environment.nsw.gov.au). If human remains are found, stop work, secure the site, and notify NSW Police and Heritage NSW.*

To ensure the greatest possible protection to the area's Aboriginal cultural heritage values, the following recommendations are made:

1) The proposed work may proceed at the Kingswood Carpark without further archaeological investigation under the following conditions:
    a) All land and ground disturbance activities must be confined to within the study area, as this will eliminate the risk of harm to Aboriginal objects in adjacent landforms. Should the parameters of the project extend beyond the assessed areas, then further archaeological assessment may be required.
    b) All staff and contractors involved in the proposed work should be made aware of the legislative protection requirements for all Aboriginal sites and objects.
2) This assessment has concluded that there is a low likelihood that the proposed work will adversely harm Aboriginal cultural heritage items or sites. If during works, however, Aboriginal artefacts or skeletal material are noted, all work should cease and the procedures in the *Unanticipated Finds Protocol* (**Appendix 2**) should be followed.

3) Inductions for work crews should include a cultural heritage awareness procedure to ensure they recognise Aboriginal artefacts (see **Appendix 3**) and are aware of the legislative protection of Aboriginal objects under the *National Parks and Wildlife Act 1974* and the contents of the *Unanticipated Finds Protocol.*

4) The information presented here meets the requirements of the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales*. It should be retained as shelf documentation for five years as it may be used to support a defence against prosecution in the event of unanticipated harm to Aboriginal objects.

<u>Historic cultural heritage</u>

A search of the State Heritage Register (SHR) and the Penrith Local Environmental Plan (LEP) returned no state or local heritage items within the study area.

Research of historic documentation indicated that prior to the current car park at the study area, the area was agricultural land. Therefore, there is a low likelihood of significant archaeological deposits within the study area.

The investigation undertaken for this report concludes that there is a low likelihood that the construction of a multistorey complex will adversely harm historic heritage items or sites.

To ensure the greatest possible protection to the area's historic cultural heritage values, the following recommendations are made:

5) All works associated with the construction of the proposed multi-story complex, if remaining within Lot 1 DP198211, will not adversely harm the heritage listed Penrith General Cemetery located across Cox Avenue, 20 metres to the north.

6) If during works, historic artefacts are noted, all work should cease and the procedures in the *Unanticipated Finds Protocol* should be followed (**Appendix 4**).

CONTENTS

FIGURES

TABLES

1 INTRODUCTION

1.1 BRIEF DESCRIPTION OF THE PROJECT

OzArk Environment & Heritage (OzArk) has been engaged by WSP Australia Pty Limited, on behalf of Penrith City Council (PCC) to complete a heritage assessment for the Kingswood Commuter Car Park Project (the project). This report assesses both Aboriginal cultural heritage values and historic heritage values that may be impacted by the project. The project is in the Penrith Local Government Area (LGA) (**Figure 1-1**).

This assessment was completed at a desktop level and did not involve a visual inspection.

1.2 STUDY AREA

The study area is approximately 3.6 kilometres (km) to the east of the Nepean River and 745 metres (m) to the east of the Parker Street, Richmond Road, and the Great Western Motorway intersection. The study area is shown on **Figure 1-2**.

1.3 ASSESSMENT APPROACH

Aboriginal cultural heritage

The desktop inspection component for the study area follows the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (due diligence; DECCW 2010).

Historic heritage

This assessment applies the Heritage Council's *Historical Archaeology Code of Practice* (Heritage Council 2006) in the completion of a historical heritage assessment.

Figure 1-1: Map showing the location of the study area.

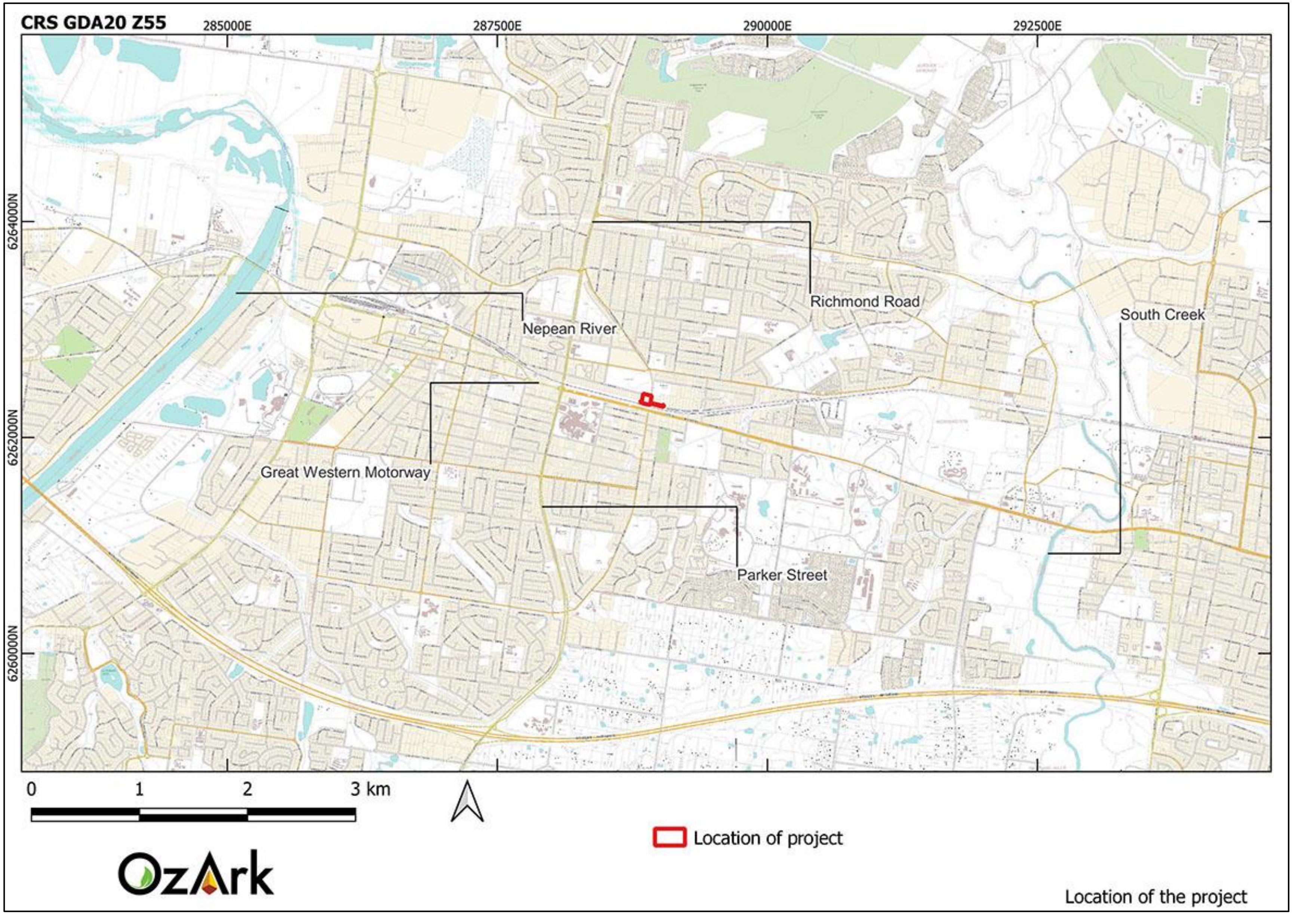
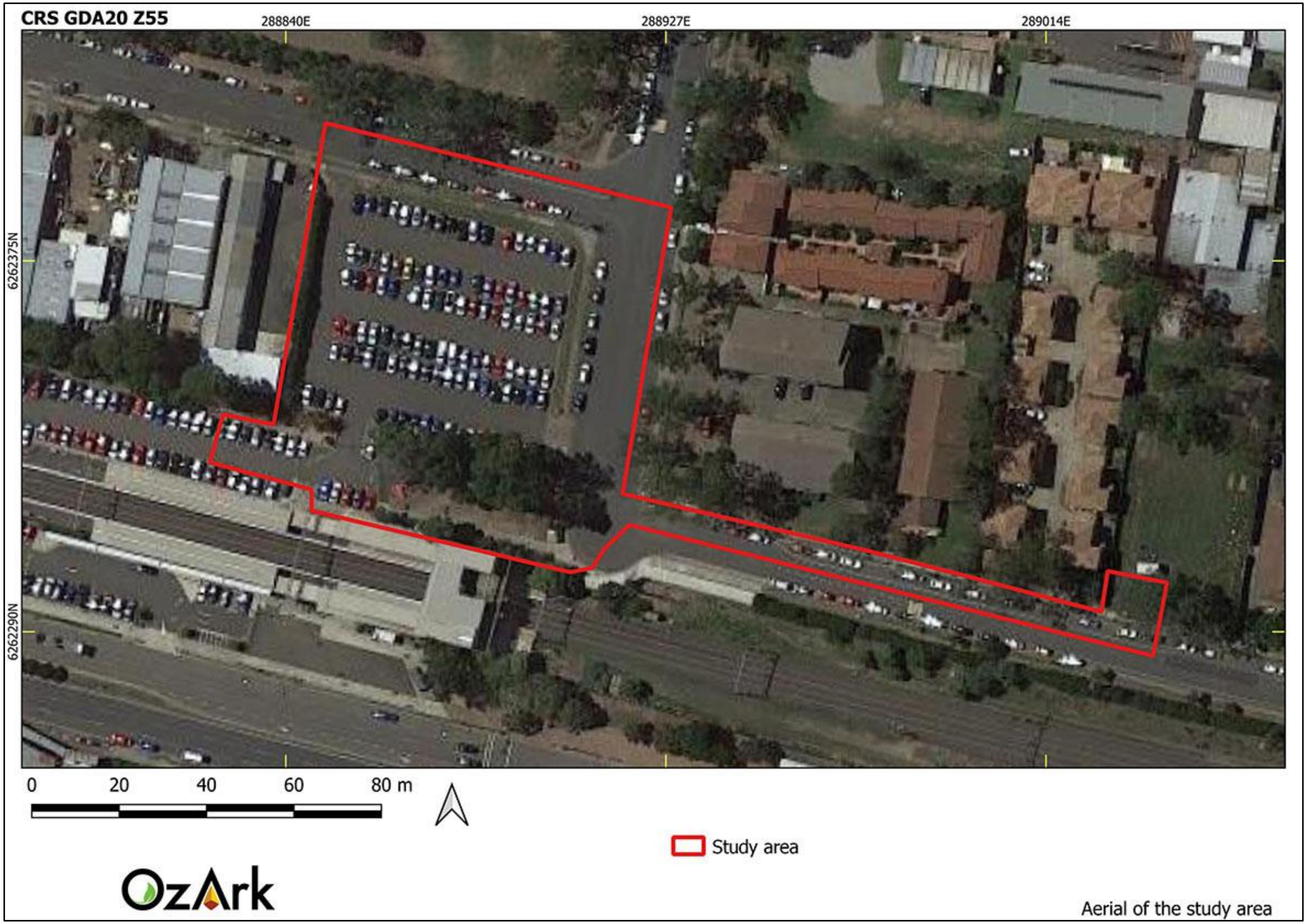


Figure 1-2: Aerial showing the study area.



2 ABORIGINAL DUE DILIGENCE ASSESSMENT

2.1 INTRODUCTION

Section 57 of the National Parks and Wildlife Regulation 2019 (NPW Regulation) made under the *National Parks and Wildlife Act 1974* (NPW Act) advocates a due diligence process to determining likely impacts on Aboriginal objects. Carrying out due diligence provides a defence to the offence of harming Aboriginal objects and is an important step in satisfying Aboriginal heritage obligations in NSW.

2.2 DEFENCES UNDER THE NPW REGULATION 2009

2.2.1 Low impact activities

The first step before application of the due diligence process itself is to determine whether the proposed activity is a “low impact activity” for which there is a defence in the NPW Regulation. The exemptions are listed in Section 58 of the NPW Regulation (DECCW 2010: 6).

The activities of PCC are not considered to be a ‘low impact activity’ and the due diligence process must be applied.

2.2.2 Disturbed lands

Relevant to this process is the assessed levels of previous land-use disturbance.

The NPW Regulation Section 58 (DECCW 2010: 18) define disturbed land as follows:

> *Land is disturbed if it has been the subject of a human activity that has changed the land’s surface, being changes that remain clear and observable.*
>
> *Examples include ploughing, construction of rural infrastructure (such as dams and fences), construction of roads, trails and tracks (including fire trails and tracks and walking tracks), clearing vegetation, construction of buildings and the erection of other structures, construction or installation of utilities and other similar services (such as above or below ground electrical infrastructure, water or sewerage pipelines, stormwater drainage and other similar infrastructure) and construction of earthworks.*

As the proposed works are in previously cleared landforms which contain established industrial infrastructure (the current carpark and part of Park Avenue) it could be considered that the proposed work is occurring in ‘disturbed land’. However, as the project intends to excavate metres underground for an underground section of the carpark, the subsurface deposit is considered undisturbed and may contain or Aboriginal objects. Therefore, as a precautionary measure, the due diligence process will be applied to the project.

In summary, it is determined that the project must be assessed under the Due Diligence Code. The reasoning for this determination is set out in **Table 2-1**.

Table 2-1: Determination of whether Due Diligence Code applies.

Item	Reasoning	Answer
Is the activity a Part 3A project declared under section 75B of the EP&A Act?	The project is assessed under Part 5 of the EP&A Act.	No
Is the activity exempt from the NPW Act or NPW Regulation?	The project is not exempt under this Act or Regulation.	No
Do either or both of these apply: Is the activity in an Aboriginal place? Have previous investigations that meet the requirements of this Code identified Aboriginal objects?	The activity will not occur in an Aboriginal place. No previous investigations have been conducted.	No
Is the activity a low impact one for which there is a defence in the NPW Regulation?	The project is not a low impact activity for which there is a defence in the NPW Regulation.	No
Is the activity occurring entirely within areas that are assessed as 'disturbed lands'?	The land underneath the current carpark is potentially undisturbed, and following the precautionary principle, the due diligence process will be followed.	No
Due Diligence Code of Practice assessment is required		

2.3 Application of the Due Diligence Code of Practice to the project

To follow the generic due diligence process, a series of steps in a question/answer flowchart format (DECCW 2010: 10) are applied to the proposed impacts and the study area, and the responses documented.

2.3.1 Step 1

Will the activity disturb the ground surface or any culturally modified trees?

Yes, the project will impact the ground surface, although no culturally modified trees will be harmed.

The project will involve the construction of a multi-story carpark building with underground levels. These proposed works will involve ground disturbance and subsurface disturbance.

No mature, native trees are located within the study area. Therefore, no culturally modified trees will be harmed by the project.

2.3.2 Step 2a

Are there any relevant confirmed site records or other associated landscape feature information on AHIMS?

No, there are no previously recorded sites within the study area.

A search of the Department of Premier and Cabinet administered Aboriginal Heritage Information Management System (AHIMS) database was completed on 3 June 2021 and returned

106 records for Aboriginal sites within a 10 km search area centred on the study area (GDA Zone 55, Eastings 285876–291876, Northings: 6259361–6265361 with no buffer).

The high number of site recordings in the search area reflects the concentration of developments in the area requiring environmental and heritage assessments. In addition, the inclusion of the Nepean River in the search area increases the incidents of site recordings.

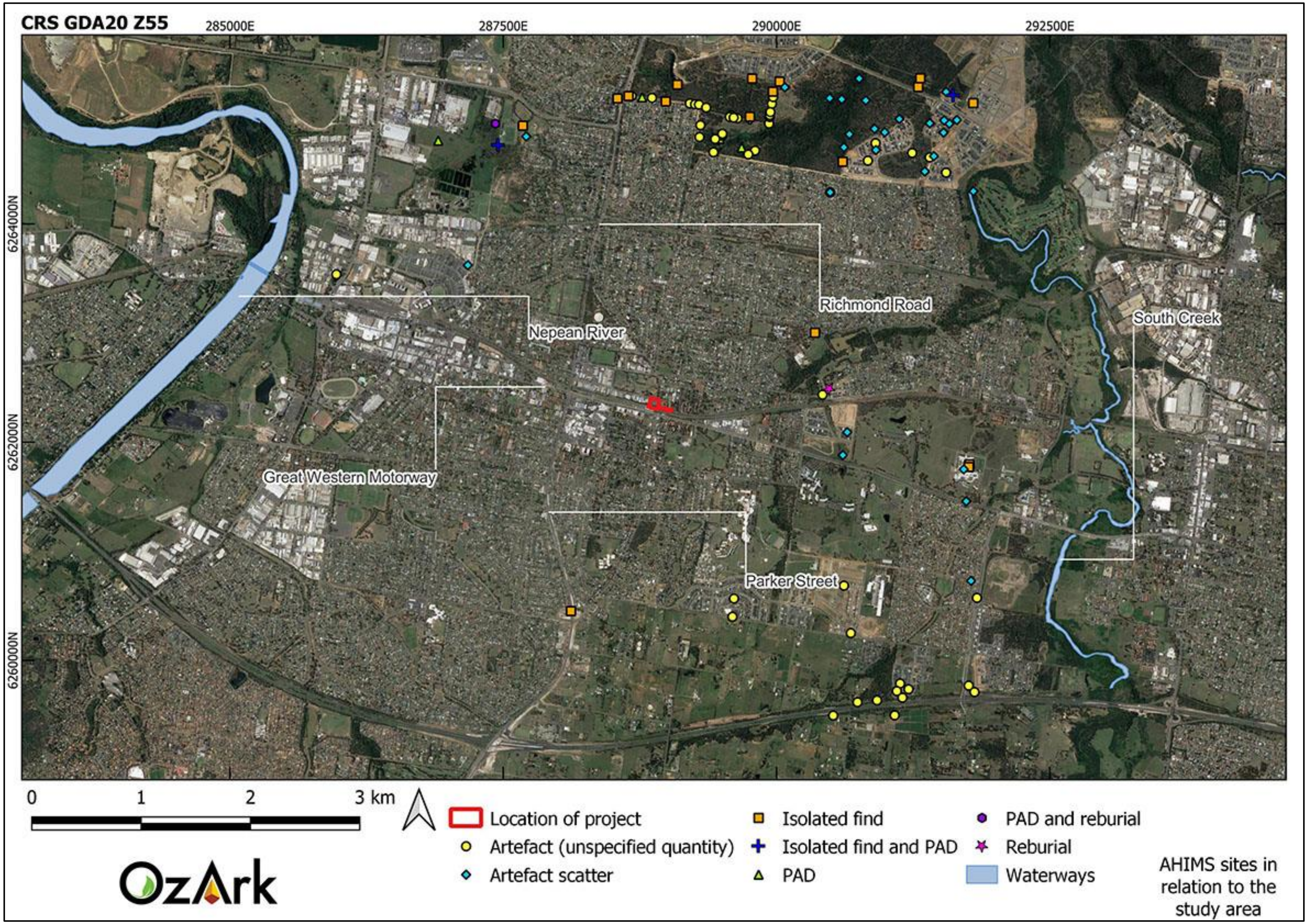
Figure 2-1 shows all previously recorded sites in relation to the study area and **Table 2-2** shows the types of sites that are close to the study area.

Table 2-2: Site types and frequencies of AHIMS sites near the study area.

Site Type	Number	% Frequency
Artefact (unspecified quantity)	49	46.2
Artefact scatter	31	29.2
Isolated find	17	16.1
Potential Archaeological Deposit (PAD)	4	3.8
Isolated find and PAD	2	1.9
Reburial	2	1.9
Reburial and PAD	1	0.9
Total	**106**	**100**

The AHIMS data shows that the most common site types surrounding the study are stone artefact sites, as these comprise 91.5% of all previously recorded sites. All the artefact scatters recorded are typically located close to a natural waterway and isolated finds are located on the outer extremities of the artefact scatter clusters. Although the previously recorded sites appear to be recorded in areas of large development driven studies, it appears that artefact scatters are more likely to be recorded in the vicinity of South Creek, rather than isolated finds, or any other site type. However, as sites with an unspecified number of artefacts are the most common site type at 46.2% in the AHIMS search, it is clear that any stone artefact site is possible to be recorded between the Nepean River and South Creek, however, the current data suggests that possibility increases closer to South Creek. The location of these waterways is shown on **Figure 2-1**.

Figure 2-1: Previously recorded sites in relation to the study area.



2.3.3 Step 2b

Are there any other sources of information of which a person is already aware?

No, there are no other sources of information that would indicate the presence of Aboriginal objects in the study area.

When the First Fleet arrived in 1788, several distinct Aboriginal groups occupied the Sydney Basin. The largest group was the Dharug (sometimes spelt Darug, Dharuk or Dharook) which spoke two main different dialects. One dialect was used east of Parramatta and between Sydney Harbour and Botany Bay, and the second dialect was used in the Hawkesbury, Blue Mountains and Nepean district. Another group to the north of Sydney Harbour spoke the Kuringai language, and the Dharawal language region covered from Botany Bay to Jervis Bay (HSC 2018, NPSW 2003).

There were a wide variety of natural resources available in the region. Fish and shellfish from coastal areas would have been a reliable source of food especially in summer, and inland there were possums, root vegetables, berries, kangaroo, mullet, and eel. In the Pennant Hills area, there is evidence of open camp sites and rock shelters. Often the rock shelters will also contain drawings, middens, animal bones, and stone artefacts. One rock shelter at Darling Mills Creek in West Pennant Hills has had occupation materials dated back to almost 12,000 years ago (HSC 2018).

The Aboriginal population for the Sydney region is estimated at being between 5,000 and 8,000 in 1788. The arrival of Europeans had a devastating effect on the Aboriginal population in the region. There was often violence between the Aboriginals and the Europeans, as well as infectious epidemics like small pox, which caused a rapid decline of the Aboriginal population in the Sydney region (NPSW 2003). Further decline in Aboriginal population was due to the loss of traditional hunting and gathering areas as the land was cleared for agricultural or grazing purposes to sustain the growing British settlement. There are several Dharug words which are used in Australian English including dingo, wallaby, koala, and wombat (HSC 2018).

While the region of the study area would have been used by traditional Aboriginal people as it is located between the Nepean River and South Creek, there is no available information that suggests that the study area contains Aboriginal objects or other features of cultural significance.

2.3.4 Step 2c

Are there any landscape features that are likely to indicate presence of Aboriginal objects?

No, the study area does not contain landforms with identified archaeological sensitivity.

The due diligence guidelines identify several landforms that have archaeological sensitivity. If a project impacts these landforms, then the Due Diligence process progresses to Step 3.

The identified landforms within the due diligence guidelines are:

- Within 200 m of waters, or
- Located within a sand dune system, or
- Located on a ridge top, ridge line or headland, or
- Located within 200 m below or above a cliff face, or
- Within 20 m of or in a cave, rock shelter, or a cave mouth, and
  on land that is <u>not disturbed land</u>

There are no landscape features that have been identified as archaeologically sensitive in the study area, and there is no waterway within 200 m of the study area. The closest permanent water source is the Nepean River and South Creek, located approximately 3.7 km to the west and 3.8 km to the east respectively.

Although many of the previously recorded sites outlined in **Section 2.3.2** are situated further than 200 m of the Nepean River and South Creek, they are predominantly recorded in areas where, from a desktop inspection, there has been limited ground surface disturbance. The study area, however, is within an area where the ground surface has been previously modified and disturbed.

Figure 2-2 to **Figure 2-8** present a series of aerial photographs of the study area spanning 1943 through to the present.

As seen on **Figure 2-2** and **Figure 2-3** that date from 1943 and 1947, the study area was used as a paddock for agricultural grazing, which appears to have continued up to at least 1965. Although there appears to be a small cluster of trees within the study area, they have since been cut down and removed.

As a result of the area previously being used for agricultural purposes, and no obvious or clear indication of Aboriginal occupation, the likelihood of Aboriginal objects being recorded in the area is low.

Figure 2-4 shows that there was construction within the study area somewhere between 1947 and 1965, as a carpark is present in the 1965 aerial imagery. From 1965 to the present, the carpark has remained the only construction within the study area, as shown in **Figure 2-4** to **Figure 2-8**.

Surrounding lots have been subject to development and expansion, such as the Kingswood train station to the south of the study area, that has been upgraded from 1943 to the present to support a significant population increase within the region. Due to this, many Aboriginal objects or sites in the nearby area have been destroyed or disturbed, and the study area is probably no exception.

In addition to the previous disturbance seen within the study area, when viewing the 1943 aerial imagery in **Figure 2-2**, no outcropping stone or ideal landforms to attract Aboriginal occupation are noted. As suggested in the predictive model in **Section 2.3.2**, isolated finds can occur anywhere in the Australian landscape, however, the historic use of land within the study area significantly diminishes the likelihood of recording of this site type.

The information gained from the aerial historical imagery on **Figure 2-2** to **Figure 2-8** show that the study area was a cleared paddock prior to the current carpark, which appears to be the only development to occur in Lot 1 DP198211. It is therefore concluded that there is a low likelihood of there being subsurface archaeological deposits beneath the current carpark due to the nature of past land use and the lack of features that would have attracted traditional Aboriginal occupation.

2.4 CONCLUSION

The due diligence process has resulted in the outcome that an Aboriginal Heritage Impact Permit (AHIP) is not required. The reasoning behind this determination is set out in **Table 2-3**.

Table 2-3: Due Diligence Code application.

Item	Reasoning	Answer
Will the activity disturb either of the following: • the ground surface where archaeological deposits are likely • mature, native trees that may be culturally modified.	The proposed works would disturb the ground surface through excavation and construction. The ground surface is assessed as having clear and observable evidence of previous European disturbance from as early as 1943. The project will not impact mature, native vegetation, as these have been removed from the study area between 1947 and 1965.	No
Are there any relevant records of Aboriginal heritage on site (AHIMS or from other sources), or landscape features that are likely to indicate presence of Aboriginal objects?	AHIMS indicated no Aboriginal sites within the study area, with the closest site located 1.5 km to the east. No landscape features in the study area indicate the likely presence of Aboriginal objects. No outcropping stone or ideal landforms for Aboriginal occupation are evident from historical aerial imagery from 1943 to 2006.	No
Will the activity impact Aboriginal objects or landforms with archaeological potential?	There are no known items of Aboriginal significance present in the study area, and landforms with identified archaeological sensitivity are not present.	No
Does the desktop assessment confirm that Aboriginal objects will be harmed?	Desktop searches found no known items of Aboriginal heritage in the study area. It is assessed that there is a low likelihood of there being subsurface archaeological deposits within the study area due to previous disturbances seen through the historical aerial imagery of the area.	No
AHIP not necessary. Proceed with caution.		

Figure 2-2: Aerial of study area in 1943.

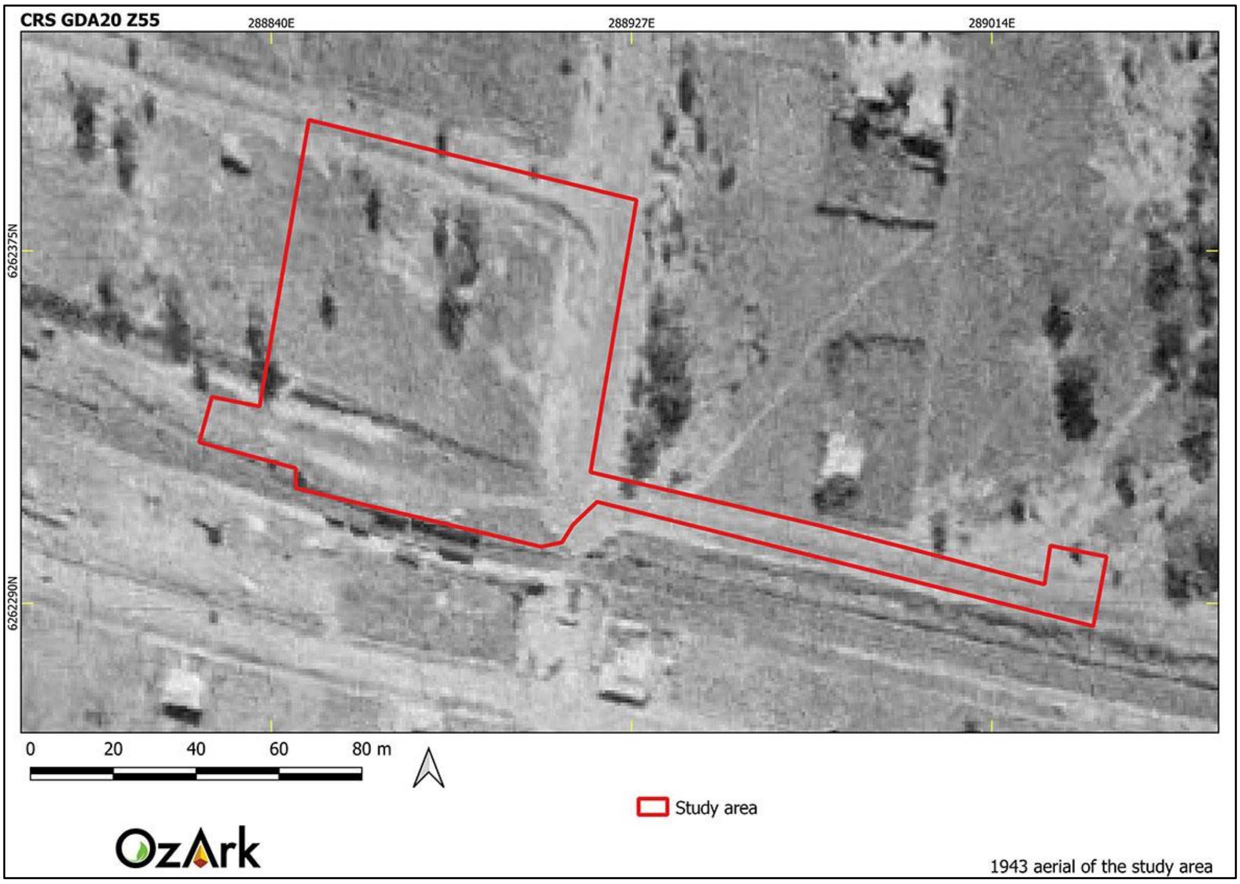


Figure 2-3: Aerial of study area in 1947.

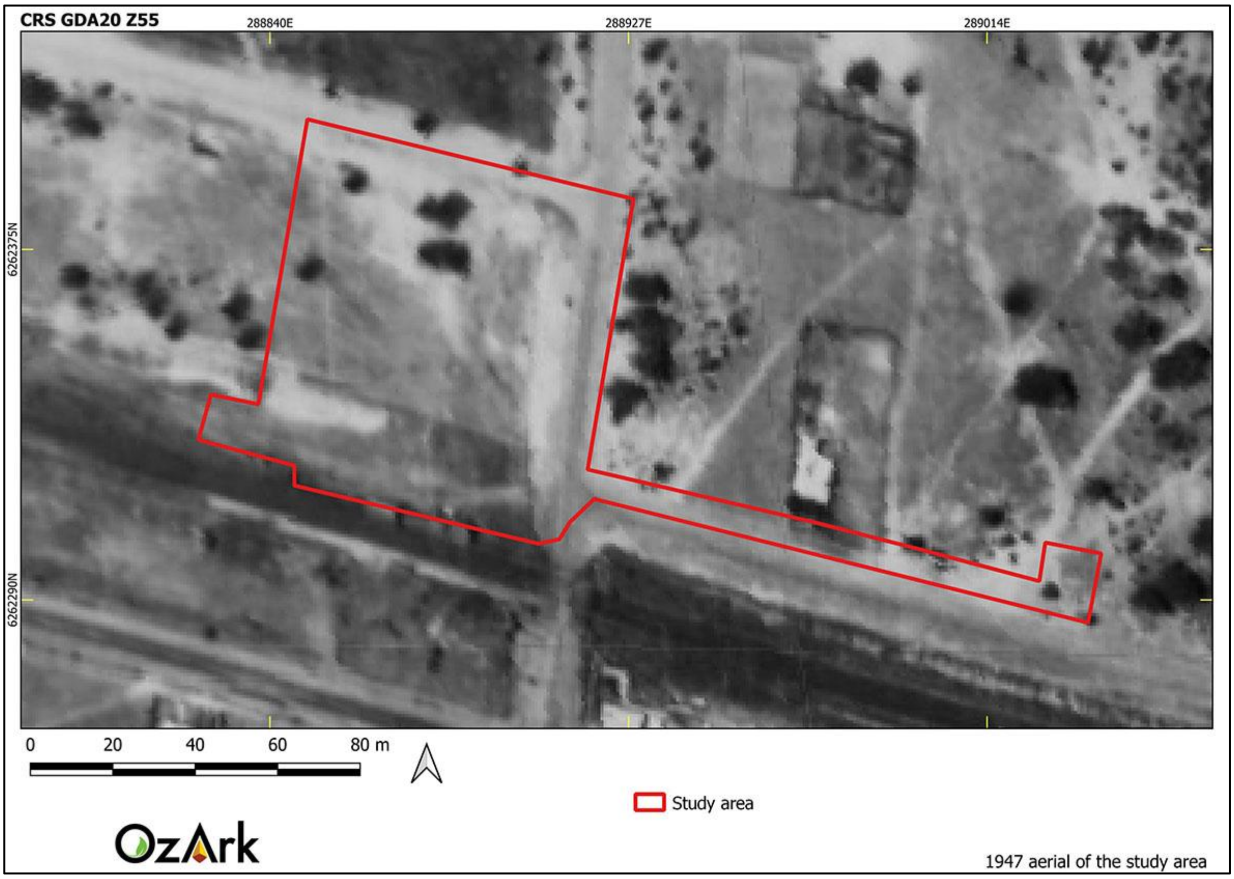


Figure 2-4: Aerial of study area in 1965.

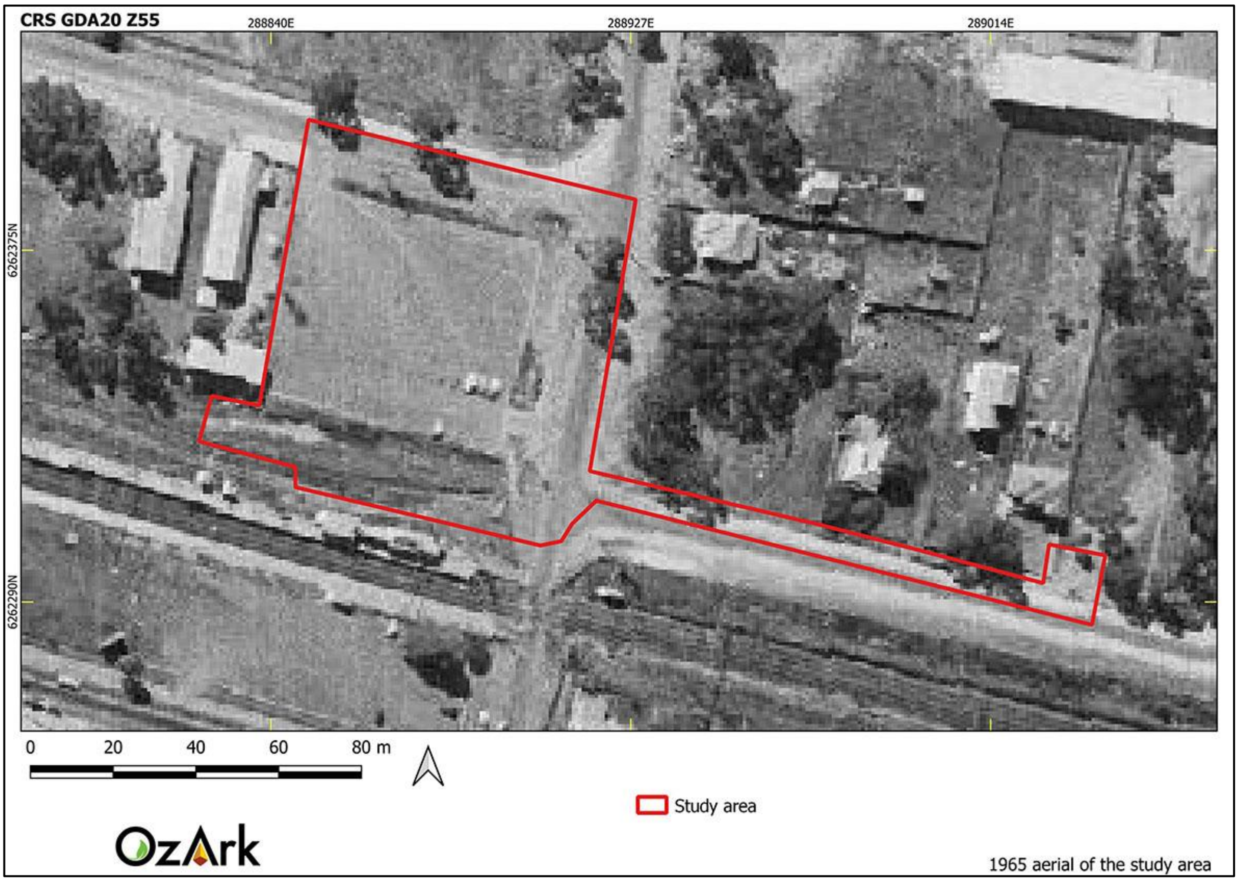


Figure 2-5: Aerial of study area in 1975.

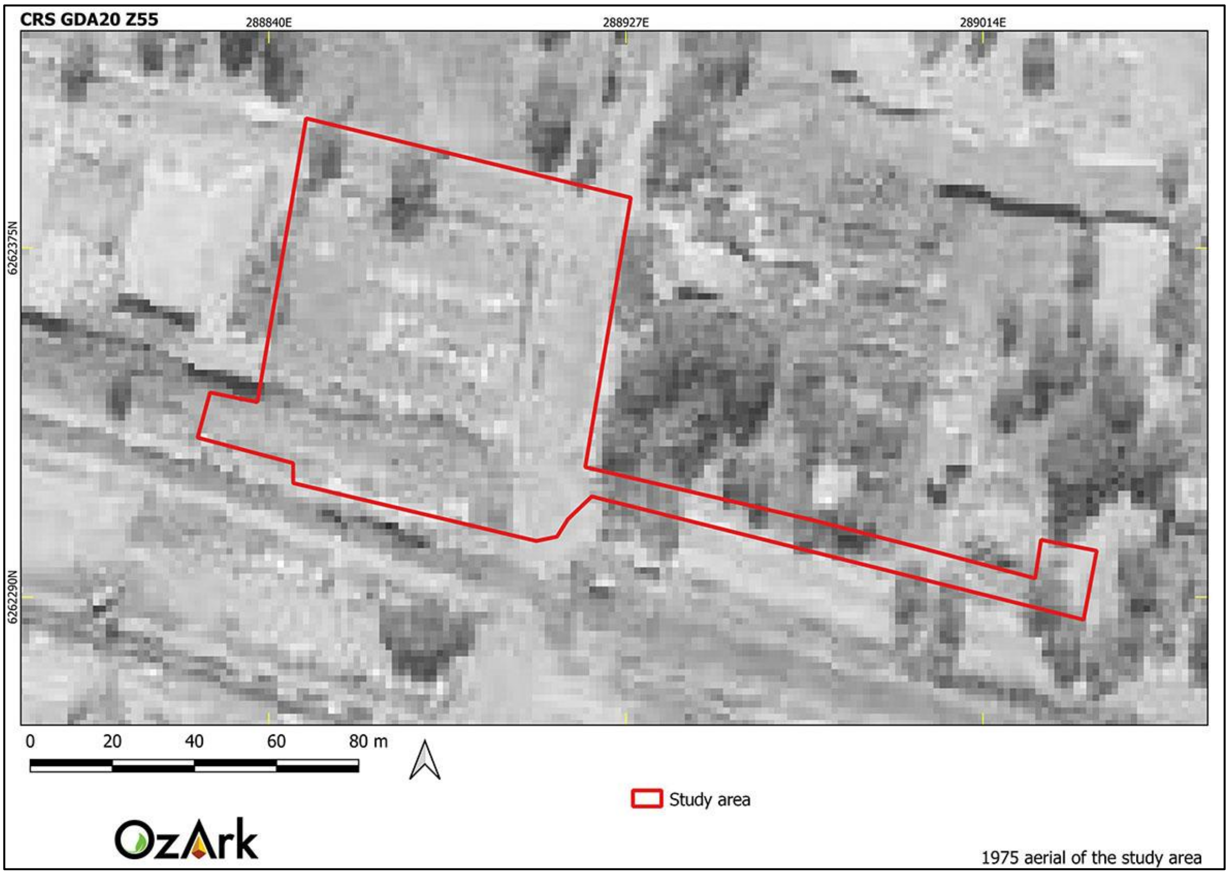


Figure 2-6: Aerial of study area in 1986.

Figure 2-7: Aerial of study area in 1991.

Figure 2-8: Aerial of study area in 2006.

3 HISTORIC HERITAGE ASSESSMENT: BACKGROUND

3.1 INTRODUCTION

The current assessment will apply the Heritage Council *Historical Archaeology Code of Practice* (Heritage Council 2006) in the completion of a historical heritage assessment.

3.2 BRIEF HISTORY OF KINGSWOOD

The suburb of Kingswood was initially a eucalyptus woodland that, despite British colonisation of Australia in 1788, remained virtually undisturbed until 1862 until the railway was constructed. In 1863, the opening of Kingswood Station occurred, however, this closed down after one year, and then reopened in 1887 when the local population began increasing. The station was initially called 'Kingswood Siding' as it was only a wooden platform and ticket office.

During Kingswood's early British occupation, the land was held by John Best in 1814, which gradually split into smaller properties that were being used for agricultural and cropping purposes. The land continued to be used for this purpose throughout the 1800s and early to mid-1900s (Stevenson 1985). Prior to the name Kingswood, the suburb was known as 'Cross Roads' as it was the location where the Great Western Highway and other major roads intersected.

Due to the increasing population in the western regions of Sydney in the late 1800s, the first subdivisions of land in Kingswood were taking place, however, it wasn't until 1914 that residential land at Kingswood was sold (Stevenson 1985).

3.3 LOCAL CONTEXT

3.3.1 Desktop database searches conducted

A desktop search was conducted on the following databases to identify any potential previously recorded heritage within the study area. The results of this search are summarised in **Table 3-1**.

Table 3-1: Historic heritage: desktop-database search results.

Name of Database Searched	Date of Search	Type of Search	Comment
National and Commonwealth Heritage Listings	03/06/21	Penrith LGA	No listings inside or adjacent to the study area.
State Heritage Listings	03/06/21	Penrith LGA	No SHR listings inside or adjacent to the study area.
Local Environmental Plan (LEP)	03/06/21	Penrith LGA	One LEP listing located across Cox Avenue from the study area.

A search of the Heritage Council of NSW administered heritage databases and the Penrith LEP returned 28 SHR listings and 128 LEP listings within the designated search area (Penrith LGA). Those listed heritage items closest to the study area are listed below.

1) Penrith General Cemetery (Penrith LEP I97) is located 20 m north of the study area, across Cox Avenue. The cemetery was dedicated in 1903 and is the largest and earliest cemetery in the LGA. It is an exceptional example of a formally laid out cemetery that is divided into eras, which is demonstrated by the brush box plantings, brick kerbs and style of memorial stones.
2) Milestone (Penrith LEP I861) is located 144 m to the southeast of the study area on the Great Western Motorway. The monument is an early remnant of the establishment of the Western Road, which linked Sydney and the Western suburbs such as Penrith.
3) Weatherboard Cottage (Penrith LEP I175) is located 770 m to the west of the study area. The cottage is an example of an 1880's weatherboard cottage that is intact and maintains the original detail.
4) House (Penrith LEP I672) is situated 600 m to the east of the study area. The house is one of the remaining early twentieth century residences in Kingswood. It displays the village settlement pattern post late nineteenth century subdivision.
5) Penrith Railway Station group (SHR 01222) is located approximately 2.4 km to the west of the study area. Buildings within the Penrith Railway Station date to the 1860s and 1890s, which are classic and somewhat intact examples of Victorian second-class and third-class station buildings. It was this station that essentially pathed way for the development of the western railway line across the Blue Mountains.

The heritage listings near the study area are shown on **Figure 3-1**.

3.4 HERITAGE VALUES OF THE STUDY AREA

As the study area contains no current or past evidence of infrastructure, no built or moveable heritage items will be harmed by the project. Therefore, the study area has no heritage values.

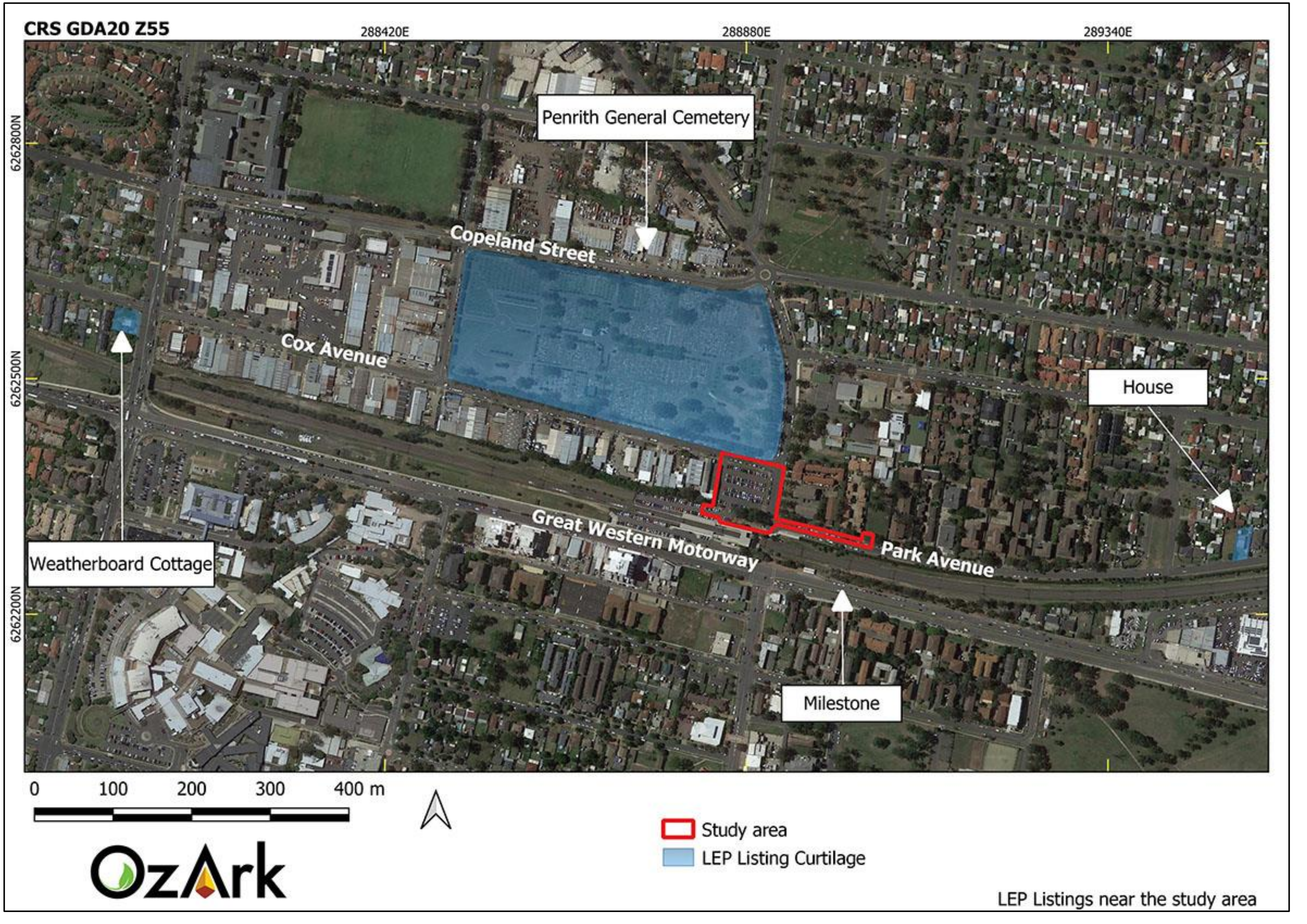
3.5 ARCHAEOLOGICAL ASSESSMENT

As seen in the historical aerials in **Figure 2-2** to **Figure 2-8**, no previous structures or clearly defined sensitive landforms were evident within the study area. Thus, no sub surface archaeological deposits are likely within the study area.

3.6 CONCLUSION

The construction of the Kingswood multi storey complex will not harm any known heritage values or sub surface archaeological deposits, as no heritage values or sub surface archaeological deposits are evident within the study area.

Figure 3-1: Nearby listed heritage items in relation to the study area.



4 MANAGEMENT RECOMMENDATIONS

4.1 ABORIGINAL CULTURAL HERITAGE

The undertaking of the due diligence process resulted in the conclusion that the proposed works will have an impact on the ground surface, however, no Aboriginal objects or intact archaeological deposits will be harmed by the project. This moves the project to the following outcome:

> *AHIP application not necessary. Proceed with caution. If any Aboriginal objects are found, stop work, and notify Heritage NSW (02) 9873 8500 (heritagemailbox @environment.nsw.gov.au) . If human remains are found, stop work, secure the site, and notify NSW Police and Heritage NSW.*

To ensure the greatest possible protection to the area's Aboriginal cultural heritage values, the following recommendations are made:

1) The proposed work may proceed at the Kingswood Carpark without further archaeological investigation under the following conditions:
    a) All land and ground disturbance activities must be confined to within the study area, as this will eliminate the risk of harm to Aboriginal objects in adjacent landforms. Should the parameters of the project extend beyond the assessed areas, then further archaeological assessment may be required.
    b) All staff and contractors involved in the proposed work should be made aware of the legislative protection requirements for all Aboriginal sites and objects.
2) This assessment has concluded that there is a low likelihood that the proposed work will adversely harm Aboriginal cultural heritage items or sites. If during works, however, Aboriginal artefacts or skeletal material are noted, all work should cease and the procedures in the *Unanticipated Finds Protocol* (**Appendix 2**) should be followed.
3) Inductions for work crews should include a cultural heritage awareness procedure to ensure they recognise Aboriginal artefacts (see **Appendix 3**) and are aware of the legislative protection of Aboriginal objects under the *National Parks and Wildlife Act 1974* and the contents of the *Unanticipated Finds Protocol.*
4) The information presented here meets the requirements of the Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales. It should be retained as shelf documentation for five years as it may be used to support a defence against prosecution in the event of unanticipated harm to Aboriginal objects.

4.2 HISTORIC HERITAGE

The investigation undertaken for this report concludes that there is a low likelihood that the construction of a multistorey complex will adversely harm historic heritage items or sites.

To ensure the greatest possible protection to the area's historic cultural heritage values, the following recommendations are made:

5) All works associated with the construction of the proposed multi-story complex, if remaining within Lot 1 DP198211, will not adversely harm the heritage listed Penrith General Cemetery located across Cox Avenue, 20 metres to the north.
6) If during works, historic artefacts are noted, all work should cease and the procedures in the *Unanticipated Finds Protocol* should be followed (**Appendix 4**).

REFERENCES

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DECCW 2010	DECCW. 2010. Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW. Department of Environment, Climate Change and Water, Sydney.
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HSC 2018	Hills Shire Council. 2018. Aborigines in the Hills District. Available at: https://www.thehills.nsw.gov.au/Library/Library-e-Resources/Local-Studies-Family-History/A-Brief-History-of-the-Shire#Aboriginal.
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NPWS 2003	NSW National Parks and Wildlife Service. Chapter 15: The Sydney Basin Bioregion. In:The bioregions of New South Wales – their biodiversity, conservation and history.
OEH 2011	Office of Environment and Heritage. 2011. Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in New South Wales. Department of Environment, Climate Change and Water, Sydney.
Stevenson 1985	Stevenson, Colin. R. 1985. Place Names and their Origins within the City of Penrith. Penrith City Council, Penrith.

APPENDIX 1: AHIMS SEARCH RESULTS

Office of Environment & Heritage — NSW Government

AHIMS Web Services (AWS)
Extensive search - Site list report

Your Ref/PO Number : Kingswood Carpark 3
Client Service ID : 595984

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
45-5-3326	ADI/FF-1	AGD	56	289922	6265112	Open site	Valid	Artefact : 1		99635,102450
	Contact T Russell	Recorders	Jo McDonald Cultural Heritage Management see GML					Permits		
45-5-3334	ADI/FF-33	GDA	56	291401	6264923	Open site	Destroyed	Artefact : 7		99635
	Contact T Russell	Recorders	Jo McDonald Cultural Heritage Management see GML,GML Heritage Pty Ltd - Surry					Permits	3647	
45-5-3335	ADI/FF-34	GDA	56	291356	6264481	Open site	Destroyed	Artefact : 3		99635
	Contact T Russell	Recorders	Jo McDonald Cultural Heritage Management see GML,GML Heritage Pty Ltd - Surry					Permits	3647	
45-5-1019	ADI-11	GDA	56	291800	6264300	Open site	Destroyed	Artefact : -	Open Camp Site	
	Contact	Recorders	Margrit Koettig,Rex Silcox,Miss.Marjorie Sullivan,Phil Hughes,GML Heritage Pty Ltd					Permits	3647	
45-5-3317	Western Sydney 5	GDA	56	287679	6264900	Open site	Valid	Artefact : 1		100554,102450
	Contact Searle	Recorders	Navin Officer Heritage Consultants Pty Ltd					Permits		
45-5-3318	Western Sydney 6	GDA	56	287710	6264801	Open site	Valid	Artefact : 5		100554,102450
	Contact Searle	Recorders	Navin Officer Heritage Consultants Pty Ltd					Permits		
45-5-3319	Western Sydney 7 and PAD	GDA	56	287450	6264725	Open site	Valid	Artefact : 1, Potential Archaeological Deposit (PAD) : -		100554,102450
	Contact Searle	Recorders	Navin Officer Heritage Consultants Pty Ltd,Biosis Pty Ltd - Wollongong,Mrs.Samant					Permits		
45-5-1025	ADI-24;	AGD	56	288540	6264980	Open site	Valid	Artefact : -	Isolated Find	102155,102450
	Contact	Recorders	Doctor.Jo McDonald					Permits		
45-5-3393	Claremont Meadows South West 1 (CMSW 1)	GDA	56	291100	6259720	Open site	Valid	Artefact : -		99122,103732
	Contact	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits	2899,3219	
45-5-3394	Claremont Meadows South West 2 (CMSW 2)	GDA	56	291130	6259790	Open site	Valid	Artefact : -		99122
	Contact	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits	2876	
45-5-3395	Claremont Meadows South West 3 (CMSW 3)	GDA	56	291100	6259720	Open site	Valid	Artefact : -		99122,103732
	Contact	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits	2899,3219	
45-5-3396	Claremont Meadows South West 4 (CMSW 4)	GDA	56	291207	6259737	Open site	Valid	Artefact : -		99122,103732
	Contact	Recorders	Kelleher Nightingale Consulting Pty Ltd,ERM Australia Pty Ltd- Sydney CBD,Miss.K					Permits	2899,3219	
45-5-3397	Claremont Meadows South West 5 (CMSW 5)	GDA	56	291080	6259500	Open site	Valid	Artefact : -		99122,103732
	Contact	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits	2899,3219	
45-5-3398	Claremont Meadows South West 6 (CMSW 6)	GDA	56	291080	6259498	Open site	Valid	Artefact : -		99122
	Contact	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits	2876	
45-5-3953	Cobham OC1	GDA	56	291735	6261459	Open site	Valid	Artefact : 50		
	Contact	Recorders	Mary Dallas Consulting Archaeologists (MDCA),Mr.Paul Irish					Permits		
45-5-3993	Cobham IF1	GDA	56	291765	6261797	Open site	Valid	Artefact : 1		

Report generated by AHIMS Web Service on 03/06/2021 for Brendan Fisher for the following area at Datum :GDA, Zone : 56, Eastings : 285876 - 291876, Northings : 6259361 - 6265361 with a Buffer of 0 meters. Additional Info : Background information. Number of Aboriginal sites and Aboriginal objects found is 106

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Office of Environment & Heritage — NSW Government

AHIMS Web Services (AWS)
Extensive search - Site list report

Your Ref/PO Number : Kingswood Carpark 3
Client Service ID : 595984

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Mary Dallas Consulting Archaeologists (MDCA),Mr.Paul Irish					Permits		
45-5-3994	Cobham IF2	GDA	56	291759	6261773	Open site	Valid	Artefact : 1		
	Contact	Recorders	Mary Dallas Consulting Archaeologists (MDCA),Mr.Paul Irish					Permits		
45-5-5238	Andrews Road PAD 1	GDA	56	286905	6264763	Open site	Valid	Artefact : -		104180
	Contact	Recorders	Biosis Pty Ltd - Wollongong,Mrs.Samantha Keats					Permits	4518	
45-5-1026	ADI-25;	AGD	56	288880	6264930	Open site	Valid	Artefact : -	Isolated Find	102155,102450,102573
	Contact	Recorders	Doctor.Jo McDonald					Permits		
45-5-1027	ADI-26	AGD	56	288986	6265084	Open site	Valid	Artefact : -	Isolated Find	99635,102155,102450,102573,102577
	Contact	Recorders	Doctor.Jo McDonald,Jo McDonald Cultural Heritage Management see GML					Permits		
45-5-1029	ADI-28;	AGD	56	289670	6265140	Open site	Valid	Artefact : -	Isolated Find	102450,102573,102577,103618
	Contact	Recorders	Doctor.Jo McDonald					Permits	3057	
45-5-1030	ADI-29;	AGD	56	289860	6265020	Open site	Valid	Artefact : -	Isolated Find	102450,102577
	Contact	Recorders	Doctor.Jo McDonald					Permits		
45-5-1031	ADI-30;	AGD	56	289650	6264760	Open site	Valid	Artefact : -	Open Camp Site	102450
	Contact	Recorders	Doctor.Jo McDonald					Permits		
45-5-1032	ADI-31;	AGD	56	289650	6264790	Open site	Valid	Artefact : -	Isolated Find	102450
	Contact	Recorders	Doctor.Jo McDonald					Permits		
45-5-2406	ASD1;Kingswood;	AGD	56	290500	6261690	Open site	Valid	Artefact : -	Open Camp Site	
	Contact	Recorders	Mary Dallas Consulting Archaeologists (MDCA)					Permits		
45-5-2407	ASD2;Kingswood;	AGD	56	290540	6261900	Open site	Valid	Artefact : -	Open Camp Site	
	Contact	Recorders	Mary Dallas Consulting Archaeologists (MDCA)					Permits		
45-5-0356	Claremont Creek	AGD	56	291673	6260538	Open site	Destroyed	Artefact : -	Open Camp Site	260,1018
	Contact	Recorders	Jenny Hanrahan					Permits		
45-5-0266	South Creek;;	GDA	56	291550	6264470	Open site	Destroyed	Artefact : -	Open Camp Site	260,1018
	Contact	Recorders	Margrit Koettig,GML Heritage Pty Ltd - Surry Hills,Ms.Erin Mein					Permits	3647	
45-5-0702	WD63	AGD	56	290650	6265140	Open site	Valid	Artefact : -	Open Camp Site	1380,102450,102577
	Contact	Recorders	Laura-Jane Smith					Permits	873	
45-5-0703	WD64	AGD	56	290560	6264630	Open site	Valid	Artefact : -	Open Camp Site	1380
	Contact	Recorders	Laura-Jane Smith					Permits		
45-5-0704	WD65	GDA	56	290905	6264740	Open site	Destroyed	Artefact : -	Open Camp Site	1380,102577

Report generated by AHIMS Web Service on 03/06/2021 for Brendan Fisher for the following area at Datum :GDA, Zone : 56, Eastings : 285876 - 291876, Northings : 6259361 - 6265361 with a Buffer of 0 meters. Additional Info : Background information. Number of Aboriginal sites and Aboriginal objects found is 106

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AHIMS Web Services (AWS)

Extensive search - Site list report

Office of Environment & Heritage — NSW Government

Your Ref/PO Number : Kingswood Carpark 3

Client Service ID : 595984

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Laura-Jane Smith,GML Heritage Pty Ltd - Surry Hills,Ms.Erin Mein					Permits	3647	
45-5-0705	WD66	AGD	56	290790	6264680	Open site	Valid	Artefact : -	Open Camp Site	1380,102450
	Contact	Recorders	Laura-Jane Smith					Permits		
45-5-0708	WD69	AGD	56	290380	6264960	Open site	Valid	Artefact : -	Open Camp Site	1380,102450
	Contact	Recorders	Laura-Jane Smith					Permits		
45-5-0709	WD70	AGD	56	289970	6265060	Open site	Valid	Artefact : -	Open Camp Site	1380,102450
	Contact	Recorders	Laura-Jane Smith					Permits		
45-5-0710	WD71	AGD	56	290510	6264510	Open site	Valid	Artefact : -	Open Camp Site	1380
	Contact	Recorders	Laura-Jane Smith					Permits		
45-5-0711	WD-72	GDA	56	290490	6264290	Open site	Destroyed	Artefact : -	Open Camp Site	1380,102577
	Contact	Recorders	Laura-Jane Smith,GML Heritage Pty Ltd - Surry Hills,Ms.Erin Mein					Permits	3647	
45-5-0712	WD73	GDA	56	290835	6264580	Open site	Destroyed	Artefact : -	Open Camp Site	1380,102577
	Contact	Recorders	Laura-Jane Smith,GML Heritage Pty Ltd - Surry Hills,Ms.Erin Mein					Permits	3647	
45-5-0713	WD74;;	GDA	56	291240	6264650	Open site	Destroyed	Artefact : -	Open Camp Site	1380,102577
	Contact	Recorders	Laura-Jane Smith,GML Heritage Pty Ltd - Surry Hills,Ms.Erin Mein					Permits	3647	
45-5-0714	WD75;	GDA	56	291400	6264610	Open site	Destroyed	Artefact : -	Open Camp Site	1380
	Contact	Recorders	Laura-Jane Smith,GML Heritage Pty Ltd - Surry Hills,Ms.Erin Mein					Permits	3647	
45-5-3621	SW1 (Penrith)	GDA	56	291712	6261752	Open site	Valid	Artefact : 3		
	Contact	Recorders	Mr.Paul Irish,Doctor.Alan Williams					Permits		
45-5-3595	ADI-CP9 (Springwood)	GDA	56	290909	6264677	Open site	Destroyed	Artefact : 2		
	Contact	Recorders	Jo McDonald Cultural Heritage Management see GML,GML Heritage Pty Ltd - Surry					Permits	3647	
45-5-3596	ADI-CP7 (Springwood)	GDA	56	291551	6265210	Open site	Destroyed	Artefact : 18		
	Contact	Recorders	Jo McDonald Cultural Heritage Management see GML,GML Heritage Pty Ltd - Surry					Permits	3647	
45-5-3601	ADI: FF/33	GDA	56	291401	6264923	Open site	Destroyed	Artefact : 7		
	Contact	Recorders	Jo McDonald Cultural Heritage Management see GML,GML Heritage Pty Ltd - Surry					Permits	3647	
45-5-3602	ADI: FF/34	GDA	56	291356	6264481	Open site	Destroyed	Artefact : 3		
	Contact	Recorders	Jo McDonald Cultural Heritage Management see GML,GML Heritage Pty Ltd - Surry					Permits	3647	
45-5-3603	ADI-FF2 (Springwood)	GDA	56	290490	6264290	Open site	Valid	Artefact : 7		
	Contact	Recorders	Jo McDonald Cultural Heritage Management see GML					Permits		
45-5-3613	ADI-FF14 (Springwood)	GDA	56	290989	6264840	Open site	Destroyed	Artefact : 2		
	Contact	Recorders	Jo McDonald Cultural Heritage Management see GML,GML Heritage Pty Ltd - Surry					Permits	3647	
45-5-3614	ADI-FF15	GDA	56	291123	6264962	Open site	Destroyed	Artefact : 20		102450
	Contact	Recorders	Jo McDonald Cultural Heritage Management see GML,GML Heritage Pty Ltd - Surry					Permits	3647	
45-5-3615	ADI-FF16 (Springwood)	GDA	56	291296	6265254	Open site	Valid	Artefact : 1		

Report generated by AHIMS Web Service on 03/06/2021 for Brendan Fisher for the following area at Datum :GDA, Zone : 56, Eastings : 285876 - 291876, Northings : 6259361 - 6265361 with a Buffer of 0 meters. Additional Info : Background information. Number of Aboriginal sites and Aboriginal objects found is 106

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AHIMS Web Services (AWS)

Extensive search - Site list report

Office of Environment & Heritage — NSW Government

Your Ref/PO Number : Kingswood Carpark 3

Client Service ID : 595984

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Jo McDonald Cultural Heritage Management see GML					Permits		
45-5-3616	ADI-FF17 (Springwood)	GDA	56	291315	6265335	Open site	Valid	Artefact : 1		
	Contact	Recorders	Jo McDonald Cultural Heritage Management see GML					Permits		
45-5-0706	WD67	AGD	56	290710	6264940	Open site	Valid	Artefact : -	Open Camp Site	1380,102450
	Contact	Recorders	Laura-Jane Smith					Permits		
45-5-0707	WD68	AGD	56	290490	6264950	Open site	Valid	Artefact : -	Open Camp Site	1380,102450
	Contact	Recorders	Laura-Jane Smith					Permits		
45-5-3572	CRA1	GDA	56	290616	6260686	Open site	Destroyed	Artefact : -		
	Contact	Recorders	Kelleher Nightingale Consulting Pty Ltd,ERM Australia Pty Ltd- Sydney CBD,Miss.K:					Permits	3023,3274	
45-5-3573	CRA2	GDA	56	290679	6260251	Open site	Destroyed	Artefact : -		
	Contact	Recorders	Kelleher Nightingale Consulting Pty Ltd,ERM Australia Pty Ltd- Sydney CBD,Miss.K:					Permits	3023,3274	
45-5-3574	CRA3-6	GDA	56	289610	6260568	Open site	Valid	Artefact : -		
	Contact	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits	3023,3274	
45-5-3575	CRA7+8	GDA	56	289596	6260401	Open site	Valid	Artefact : -		
	Contact	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits	3023,3274	
45-5-3589	ADI-CP1 (Springwood)	GDA	56	291439	6264621	Open site	Destroyed	Artefact : 44		
	Contact	Recorders	Jo McDonald Cultural Heritage Management see GML,GML Heritage Pty Ltd - Surry					Permits	3647	
45-5-3590	ADI-CP3 (Springwood)	GDA	56	291580	6264919	Open site	Destroyed	Artefact : 25		
	Contact	Recorders	Jo McDonald Cultural Heritage Management see GML,GML Heritage Pty Ltd - Surry					Permits	3647	
45-5-3591	ADI-CP4 (Springwood)	GDA	56	291533	6264949	Open site	Destroyed	Artefact : 46		
	Contact	Recorders	Jo McDonald Cultural Heritage Management see GML,GML Heritage Pty Ltd - Surry					Permits	3647	
45-5-3592	ADI-CP5 (Springwood)	GDA	56	291527	6264837	Open site	Destroyed	Artefact : 46		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,GML Heritage Pty Ltd - Surry Hills,Ms.Erin Mein					Permits	3647	
45-5-3593	ADI-CP6 (Springwood)	GDA	56	291649	6264952	Open site	Destroyed	Artefact : 21		
	Contact	Recorders	Jo McDonald Cultural Heritage Management see GML,GML Heritage Pty Ltd - Surry					Permits	3647	
45-5-4302	TNR-3	GDA	56	288545	6265150	Open site	Valid	Artefact : 1		
	Contact	Recorders	Doctor.Jo McDonald					Permits	3619	
45-5-4575	M4-14C Claremont Creek	GDA	56	291151	6259659	Open site	Destroyed	Artefact : -		
	Contact	Recorders	Helen Brayshaw,Kelleher Nightingale Consulting Pty Ltd,Miss.Kristen Taylor					Permits	4001	
45-5-4576	M4-15 Claremont Creek	GDA	56	290518	6259496	Open site	Destroyed	Artefact : -		
	Contact	Recorders	Helen Brayshaw,Kelleher Nightingale Consulting Pty Ltd,Miss.Kristen Taylor					Permits	4001	
45-5-4578	M4- 14A Claremont Creek	GDA	56	290740	6259618	Open site	Destroyed	Artefact : -		
	Contact	Recorders	Helen Brayshaw,Kelleher Nightingale Consulting Pty Ltd,Miss.Kristen Taylor					Permits	4001	
45-5-4579	M4-14B Claremont Creek	GDA	56	290919	6259635	Open site	Destroyed	Artefact : -		

Report generated by AHIMS Web Service on 03/06/2021 for Brendan Fisher for the following area at Datum :GDA, Zone : 56, Eastings : 285876 - 291876, Northings : 6259361 - 6265361 with a Buffer of 0 meters. Additional Info : Background information. Number of Aboriginal sites and Aboriginal objects found is 106

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : Kingswood Carpark 3

Client Service ID : 595984

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Helen Brayshaw,Kelleher Nightingale Consulting Pty Ltd,Miss.Kristen Taylor					Permits	4001	
45-5-5191	Museum Drive Penrith AFT 1	GDA	56	285973	6263538	Open site	Valid	Artefact : -		
	Contact	Recorders	Kelleher Nightingale Consulting Pty Ltd,Mr.Benjamin Anderson					Permits		
45-5-5470	Andrews Road PAD 1 Reburial	GDA	56	287428	6264919	Open site	Valid	Artefact : -		
	Contact	Recorders	Biosis Pty Ltd - Wollongong,Mrs.Samantha Keats					Permits		
45-5-5485	Harold Corr Athletics Track Artefact 1	GDA	56	290351	6263003	Open site	Valid	Artefact : -		
	Contact	Recorders	Mr.William Andrews,Austral Archaeology - Wollongong					Permits		
45-5-2491	Coreeen Ave 1	AGD	56	287070	6263430	Open site	Partially Destroyed	Artefact : -	Open Camp Site	98259,102450, 103155,10336 0
	Contact	Recorders	Helen Brayshaw,Tony Kondek					Permits	1367	
45-5-2484	Northern Road	AGD	56	288013	6260261	Open site	Valid	Artefact : -	Isolated Find	
	Contact	Recorders	Ms.Claire Everett					Permits	4078	
45-5-4428	GS4	GDA	56	291833	6260574	Open site	Destroyed	Artefact : -		
	Contact	Recorders	Matthew Kelleher,Doctor.Alan Williams					Permits	3762	
45-5-4331	IF-25-1	GDA	56	290605	6264570	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Miss.Sam Cooling,Ms.Erin Mein					Permits	3647	
45-5-4334	ADI-CP10	GDA	56	291799	6265107	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Miss.Sam Cooling,Ms.Erin Mein					Permits	3647	
45-5-4423	GS5	GDA	56	291757	6259770	Open site	Valid	Artefact : -		
	Contact	Recorders	Matthew Kelleher,Doctor.Alan Williams,Kelleher Nightingale Consulting Pty Ltd,Ms					Permits	3762	
45-5-4424	Kent Road North 13	GDA	56	291810	6259711	Open site	Destroyed	Artefact : -		
	Contact	Recorders	Matthew Kelleher,Matthew Kelleher					Permits	3762	
45-5-4901	Caddens artefact reburial site	GDA	56	289936	6260751	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Shezani Nasoordeen					Permits		
45-5-4896	Site 1D IF	GDA	56	291614	6265178	Open site	Valid	Artefact : -, Potential Archaeological Deposit (PAD) : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,GML Heritage Pty Ltd - Surry Hills,Doctor.Tim Ov					Permits	4351	
45-5-4920	45-5-4873 reburial	GDA	56	290480	6262491	Open site	Valid	Artefact : -		
	Contact	Recorders	Mr.Neville Baker,Mr.Neville Baker,Sydney Water-Parramatta,Sydney Water-Parran					Permits		
45-5-4873	229 Victoria Street	GDA	56	290420	6262435	Open site	Destroyed	Artefact : -		
	Contact	Recorders	Mr.Neville Baker,Mr.Neville Baker,Sydney Water-Parramatta,Sydney Water-Parran					Permits	4096	
45-5-5402	SMDS Basin I AFT4	GDA	56	289956	6265100	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5403	SMDS Basin I AFT3	GDA	56	289968	6265163	Open site	Valid	Artefact : -		

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : Kingswood Carpark 3

Client Service ID : 595984

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5404	SMDS Basin I AFT2	GDA	56	289642	6264968	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5405	SMDS Basin I AFT1	GDA	56	289581	6264995	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5378	SMDS Basin I AFT 24	GDA	56	289803	6264672	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5379	SMDS Basin I Area 06 PAD	GDA	56	288770	6265160	Open site	Valid	Artefact : -, Potential Archaeological Deposit (PAD) : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5380	SMDS Basin I PAD03	GDA	56	289680	6264700	Open site	Valid	Artefact : -, Potential Archaeological Deposit (PAD) : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5381	SMDS Basin I Area 08 PAD	GDA	56	289480	6264780	Open site	Valid	Artefact : -, Potential Archaeological Deposit (PAD) : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5382	SMDS Basin I AFT 23	GDA	56	289741	6264637	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5383	SMDS Basin I AFT 22	GDA	56	289423	6264657	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5384	SMDS Basin I AFT 21	GDA	56	289499	6264810	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5385	SMDS Basin I AFT 20	GDA	56	289504	6264826	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5386	SMDS Basin I AFT 19	GDA	56	289438	6264778	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5387	SMDS Basin I AFT 18	GDA	56	289295	6264796	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5388	SMDS Basin I AFT 17	GDA	56	289303	6264905	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5389	SMDS Basin I AFT 16	GDA	56	288674	6265173	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5390	SMDS Basin I AFT 15	GDA	56	288860	6265155	Open site	Valid	Artefact : -		

Report generated by AHIMS Web Service on 03/06/2021 for Brendan Fisher for the following area at Datum :GDA, Zone : 56, Eastings : 285876 - 291876, Northings : 6259361 - 6265361 with a Buffer of 0 meters. Additional Info : Background information. Number of Aboriginal sites and Aboriginal objects found is 106

This information is not guaranteed to be free from error omission. Office of Environment and Heritage (NSW) and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or omission.

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : Kingswood Carpark 3

Client Service ID : 595984

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5391	SMDS Basin I AFT 14	GDA	56	289206	6265104	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5392	SMDS Basin I AFT 13	GDA	56	289254	6265096	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5393	SMDS Basin I AFT 12	GDA	56	289290	6265093	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5394	SMDS Basin I AFT 11	GDA	56	289356	6265066	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5395	SMDS Basin I AFT 10	GDA	56	289572	6264980	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5396	SMDS Basin I AFT 9	GDA	56	289607	6264974	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5397	SMDS Basin I AFT 8	GDA	56	289931	6264919	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5398	SMDS Basin I AFT 7	GDA	56	289937	6264980	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5399	SMDS Basin I AFT 6	GDA	56	289938	6264998	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		
45-5-5400	SMDS Basin I AFT5	GDA	56	289943	6265025	Open site	Valid	Artefact : -		
	Contact	Recorders	GML Heritage Pty Ltd - Surry Hills,Ms.Sophie Jennings					Permits		

Report generated by AHIMS Web Service on 03/06/2021 for Brendan Fisher for the following area at Datum :GDA, Zone : 56, Eastings : 285876 - 291876, Northings : 6259361 - 6265361 with a Buffer of 0 meters. Additional Info : Background information. Number of Aboriginal sites and Aboriginal objects found is 106

APPENDIX 2: ABORIGINAL HERITAGE: UNANTICIPATED FINDS PROTOCOL

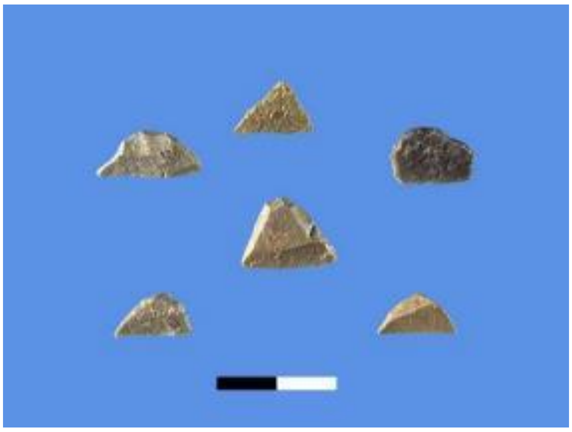
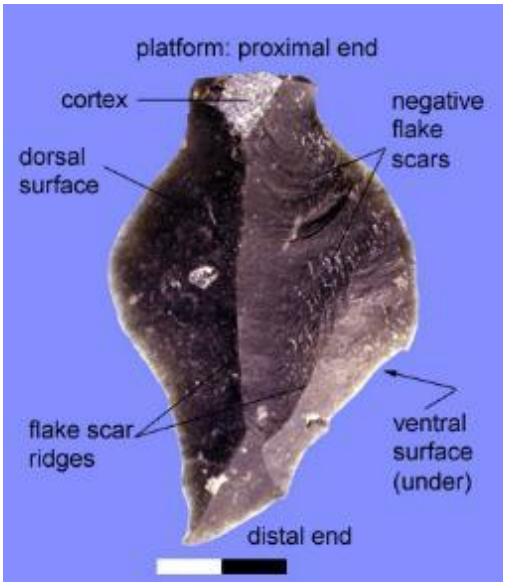
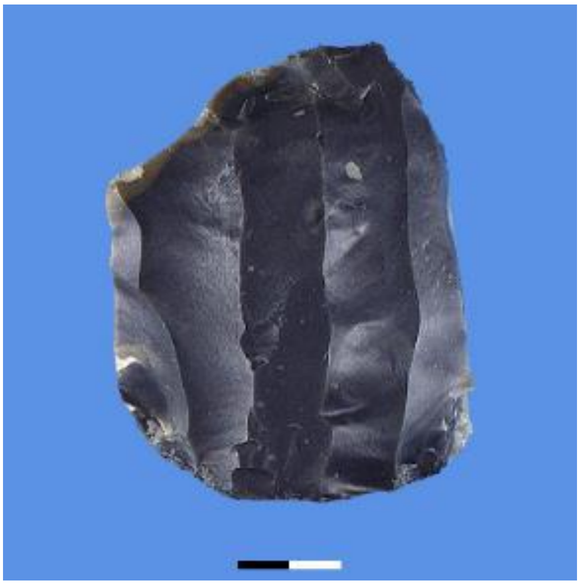
An Aboriginal artefact is anything which is the result of past Aboriginal activity. This includes stone (artefacts, rock engravings etc.), plant (culturally scarred trees) and animal (if showing signs of modification; i.e. smoothing, use). Human bone (skeletal) remains may also be uncovered while onsite.

Cultural heritage significance is assessed by the Aboriginal community and is typically based on traditional and contemporary lore, spiritual values, and oral history, and may also consider scientific and educational value.

Protocol to be followed if previously unrecorded or unanticipated Aboriginal object(s) are encountered:

1. If any Aboriginal object is discovered and/or harmed in, or under the land, while undertaking the proposed development activities, the proponent must:
   a. Not further harm the object
   b. Immediately cease all work at the particular location
   c. Secure the area so as to avoid further harm to the Aboriginal object
   d. Notify Heritage NSW as soon as practical on (02) 9873 8500, providing any details of the Aboriginal object and its location
   e. Not recommence any work at the particular location unless authorised in writing by Heritage NSW.
2. If Aboriginal burials are unexpectedly encountered during the activity, work must stop immediately, the area secured to prevent unauthorised access and NSW Police and Heritage NSW contacted.
3. Cooperate with the appropriate authorities and relevant Aboriginal community representatives to facilitate:
   a. The recording and assessment of the find(s)
   b. The fulfilment of any legal constraints arising from the find(s), including complying with Heritage NSW directions
   c. The development and implementation of appropriate management strategies, including consultation with stakeholders and the assessment of the significance of the find(s).
4. Where the find(s) are determined to be Aboriginal object(s), recommencement of work in the area of the find(s) can only occur in accordance with any consequential legal requirements and after gaining written approval from Heritage NSW (normally an Aboriginal Heritage Impact Permit).

APPENDIX 3: ABORIGINAL HERITAGE: ARTEFACT IDENTIFICATION

	
Retouched blades (scale = 1cm)	Flakes
	
Microliths (scale = 1cm)	Scraper (scale = 1cm)
	
Flake characteristics (scale = 1cm)	Core from which flakes have been removed (scale = 1cm)

APPENDIX 4: HISTORIC HERITAGE: UNANTICIPATED FINDS PROTOCOL

A historic artefact is anything which is the result of past activity not related to the Aboriginal occupation of the area. This includes pottery, wood, glass, and metal objects as well as the built remains of structures, sometimes heavily ruined.

Heritage significance of historic items is assessed by suitably qualified specialists who place the item or site in context and determine its role in aiding the community's understanding of the local area, or their wider role in being an exemplar of state or even national historic themes.

The following protocol should be followed if previously unrecorded or unanticipated historic objects are encountered:

1. All ground surface disturbance in the area of the finds should cease immediately, then:
    a) The discoverer of the find(s) will notify machinery operators in the immediate vicinity of the find(s) so that work can be halted
    b) The site supervisor will be informed of the find(s).
2. If finds are suspected to be human skeletal remains, then NSW Police must be contacted as a matter of priority.
3. If there is substantial doubt regarding the historic significance for the finds, then gain a qualified opinion from an archaeologist as soon as possible. This can circumvent proceeding further along the protocol for items which turn out not to be significant. If a quick opinion cannot be gained, or the identification is that the item is likely to be significant, then proceed to the next step.
4. Notify Heritage NSW as soon as practical on (02) 9873 8500 providing any details of the historic find and its location.
5. If in the view of the heritage specialist or Heritage NSW that the finds appear not to be significant, work may recommence without further investigation. Keep a copy of all correspondence for future reference.
6. If in the view of the heritage specialist or Heritage NSW that the finds appear to be significant, facilitate the recording and assessment of the finds by a suitably qualified heritage specialist. Such a study should include the development of appropriate management strategies.
7. If the find(s) are determined to be significant historic items (i.e. of local or state significance), any re-commencement of ground surface disturbance may only resume following compliance with any legal requirements and gaining written approval from Heritage NSW.

AHIMS Web Services (AWS)
Search Result

Your Ref/PO Number : Kingswood

Client Service ID : 699376

Date: 11 July 2022

WSP in Australia

Level 2, 121 Marcus Clarke Street
Canberra Australian Capital Territory 2600

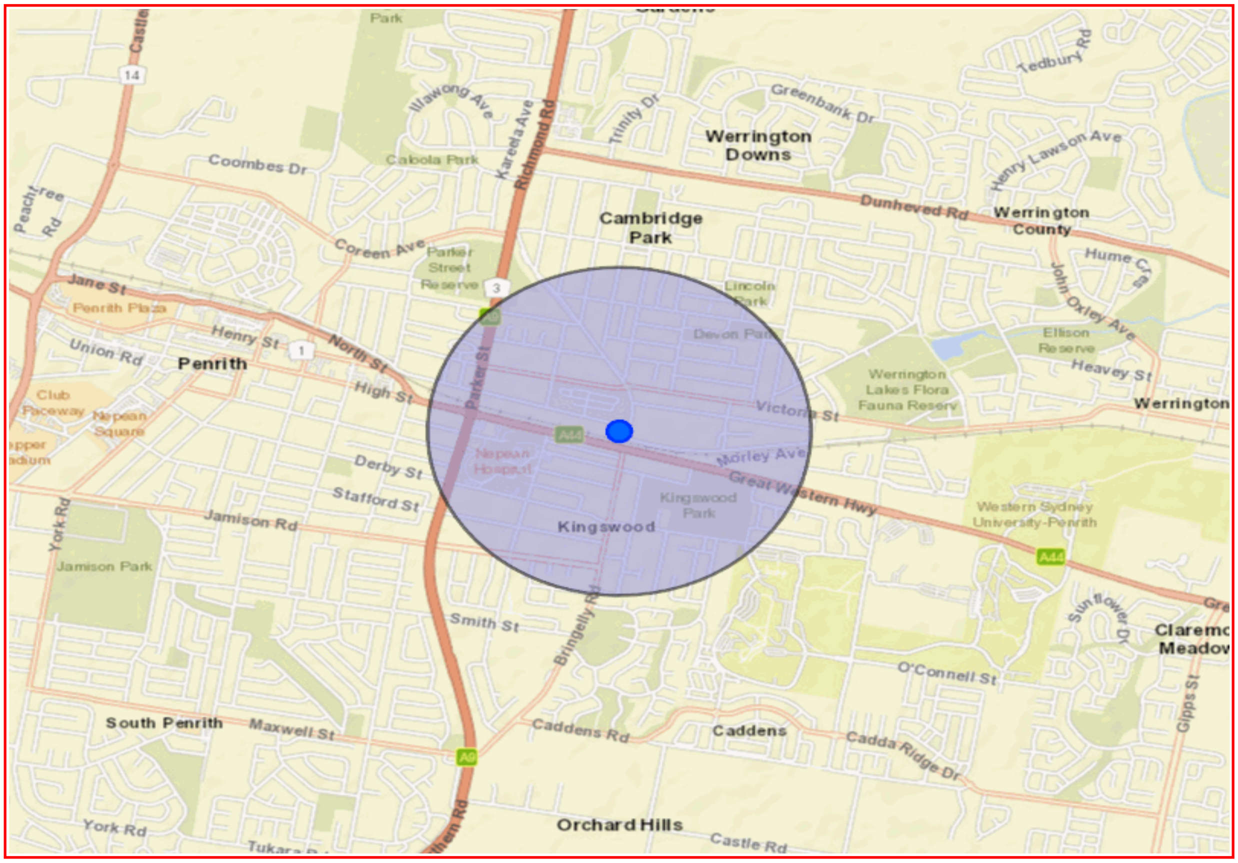
Attention: Lizzie Whiting

Email: lizzie.whiting@wsp.com

Dear Sir or Madam:

AHIMS Web Service search for the following area at Address : 6 COX AVENUE KINGSWOOD 2747 with a Buffer of 1000 meters, conducted by Lizzie Whiting on 11 July 2022.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.



A search of Heritage NSW AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	**Aboriginal sites are recorded in or near the above location.**
0	**Aboriginal places have been declared in or near the above location. ***

If your search shows Aboriginal sites or places what should you do?

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of practice.
- You can get further information about Aboriginal places by looking at the gazettal notice that declared it. Aboriginal places gazetted after 2001 are available on the NSW Government Gazette (https://www.legislation.nsw.gov.au/gazette) website. Gazettal notices published prior to 2001 can be obtained from Heritage NSW upon request

Important information about your AHIMS search

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Heritage NSW and Aboriginal places that have been declared by the Minister;
- Information recorded on AHIMS may vary in its accuracy and may not be up to date. Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings,
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in those areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.

Appendix J

Preliminary site investigation review

This appendix summarises WSP's review of environmental contamination reports pertaining to the site, relevant to this REF. General site information provided is based upon information reviewed by WSP within the Douglas Partners (DP) Preliminary Site Investigation (PSI) (Contamination) report, prepared for the site in April 2021. This PSI is hereafter referred to as "DP, 2021b".

Preliminary Site Investigation, Corner of Cox's Avenue and Richmond Road, Kingswood – Douglas Partners (2021, b)

DP was engaged by Penrith City Council in April 2021 to undertake a PSI at the site. The primary objective of this PSI was to identify potential environmental liabilities, which may impact the proposed redevelopment of the site. The proposed redevelopment included removal of the existing car park, followed by the construction of a three-storey car park structure, with parking and commercial space on the ground floor.

The desktop component of the PSI indicated that from historical aerial photography, the site was predominantly used for agricultural purposes, until redevelopment works occurred to develop the site to its current layout during the circa 1960s. Since that period, no significant redevelopment works were noted to have occurred on site.

Historical title searches indicated that between 1921 and 1961, the site may have also been used for the storage and transportation of building materials, which potentially included asbestos, during occupation of the site by "Wilson's Tile Works Pty Ltd", however this was not observed in historical aerial photography. The site was then acquired by Penrith City Council in 1961 and subsequently redeveloped into the present-day car park. Penrith City Council remains the site owner to the present-day.

A search of the NSW EPA contaminated land database indicated that the site, and surrounding properties within 500 m are not currently registered on the NSW EPA list of contaminated sites, nor were they are currently regulated by the EPA as a contaminated site. A search of the public register for public registers, licenses, applications and notices, maintained by the NSW EPA in relation to records pertaining to the site was also undertaken. The search indicated that there are currently no active or former licenses pertaining to the site.

Following review of land uses surrounding the site, it was noted that a commercial/industrial warehouse had been located upgradient to the west of the site since the circa 1950s. The PSI noted that this warehouse is currently used for the storage of cleaning chemicals. Therefore, it was considered that volatile organic compounds (VOCs) may present a risk to the site from groundwater migration from this potential source.

As part of the PSI, a site walkover and limited intrusive soil investigation were completed on site. During the walkover, no obvious evidence of contamination was encountered. Following the walkover inspection, an intrusive soil investigation was completed. This intrusive investigation involved the extension of six boreholes into readily accessible areas on site. Field observations noted that the typical soil profile consisted of fill material, at depths between 0.06 to 0.8 m below ground level (BGL), followed by residual silty clay and sand, overlying natural laminite, siltstone and sandstone.

Soil samples from various depths were submitted to the laboratory for analysis. Analytical results indicated that all results were reported at concentrations below the adopted site acceptance criteria, with the exception of benzo(a)pyrene (B(a)P) at one location, which exceeded the adopted ecological screening level. However, it was considered that the detection of B(a)P was unlikely to pose an unacceptable risk to terrestrial ecology and therefore was not considered to be of concern (DP, 2021b). No potential asbestos containing material (ACM) was encountered during the fieldwork program.

Based on the desktop assessment, potential sources of contamination included potential historical storage and transport of building materials on site between 1921 and 1961, as well as off-site sources including an industrial warehouse located directly to the west, upgradient of the site from circa 1960s. Risks associated with this of-site source included migration of VOCs to the site via groundwater. However, VOCs were not tested as part of the PSI.

The intrusive soil investigation identified the presence of fill material on site, with depths ranging from 0.06 to 0.8 mBGL. This fill was likely imported to site during the circa 1960s when the site was redeveloped to the current use. Concentrations of B(a)P in excess of the adopted site criteria was encountered in fill between 0.4–0.5 mBGL at one sample location, however this was not considered to be of concern for the proposed redevelopment. Although asbestos was not encountered within any boreholes during the investigation, due to the presence of fill soil on site, the occurrence of asbestos and/or other contaminants of potential concern (COPC's) in areas not tested cannot entirely be ruled out.

Based on the PSI, it was concluded that the site could be made suitable for the proposed development, subject to further investigations on site, which targeted potential impacts to groundwater from the industrial facility immediately to the west of the site. It was considered that a vapour assessment was considered to be the most efficient method to assess for potential impacts (refer to DP 2021 c below).

Due to the presence of fill material on site, it was also recommended that an unexpected finds protocol (UFP) be prepared and included in the construction environmental management plan (CEMP) to manage potential unexpected finds of contamination during redevelopment.

Preliminary Soil Gas Assessment – Corner of Cox's Avenue and Richmond Road, Kingswood – Douglas Partners (2021, c)

DP was engaged by Penrith City Council (c/o Root Partnerships) in June 2021 to complete a preliminary soil gas assessment at the site. The DP PSI (2021b) identified a former cleaning chemicals warehouse located immediately to the west and upgradient of the site, potentially impacting groundwater beneath the site. The PSI then recommended that a vapour assessment be undertaken to assess whether any potentially impacted groundwater at the site posed an unacceptable vapour intrusion risk to the proposed redevelopment. Therefore, this assessment was subsequently completed to assess the potential impact of VOCs to groundwater beneath the site.

The scope included the drilling of four boreholes at specific locations within the footprint of the proposed car park (and adjacent the western site boundary) to a minimum depth of 1.05 mBGL, for the construction of vapour wells. Following gas well installation, waterloo membrane samplers (WMSs) were placed within vapour wells for 24 hours to evaluate the presence/absence of soil vapours. The WMSs were then retrieved and analysed for a suite of VOCs.

Analytical results indicated that VOC concentrations in a majority of WMSs were below the laboratory LOR, with trace detections of toluene, ethylbenzene and xylene detected in boreholes BH1 and BH3 (boreholes in the northern portion of the site). Detections of toluene, ethylbenzene and xylene were well below the adopted site criteria and were not considered to pose an unacceptable risk to human-health receptors at the site. It was noted that the detections may have been associated with use of the site as a car park and the presence of historical fuel leaks from vehicles, however this potential source was not confirmed.

DP concluded that based on the results of the passive soil assessment, concentrations of VOCs on site were not considered to pose an unacceptable risk and the site was suitable for the proposed car park development. It was further noted that a UFP (as recommended in the DP PSI (2021b)) was prepared and implemented to manage any unexpected finds during the redevelopment.

Preliminary In-Situ Waste Classification Report – Corner Cox Avenue and Richmond Road, Kingswood – Douglas Partners (2021, d)

DP was engaged by Penrith City Council in June 2021 to complete a preliminary In-Situ Waste Classification assessment at the site. The primary purpose of the waste classification was to provide a preliminary waste classification assessment, based on analytical results reported in the DP PSI (2021b). The waste classification was prepared for preliminary purposes and is not suitable for waste disposal use. The waste classification report is to be confirmed by a qualified environmental consultant, prior to off-site disposal.

The assessment pertained to in-situ fill and natural materials across the site, in an approximate area of 3,240 m^2. Based on field investigations, fill material consisting of grey/brown gravelly sand, or orange/brown sand roadbase and grey/brown silty clay was encountered between 0.3 and 1.0 mBGL. This material was then underlain by natural soils, comprised of grey mottled orange/brown silty clay and weathered to fresh siltstone, laminite and sandstone.

Based on the soil analytical results, fill materials on site were preliminarily classified as General Solid Waste (GSW) – non-putrescible.

It was noted that due to the identification of imported fill across the site from an unknown source, there is the potential that asbestos is present in the fill in areas not investigated. The presence/absence of asbestos would unlikely be confirmed until the hardstand across the site is removed and underlying fill is exposed and excavated. It was also noted that B(a)P and TRH detections were detected in two natural soil samples (BH102 and BH105, located in the central and north-eastern portions of the site), above natural background conditions. It is possible that localised areas of underlying natural material had been impacted by overlying fill or other on-site sources. As a result, it was considered that a majority of natural soils were preliminarily classified as VENM, with localised areas of natural material identified to contain B(a)P and TRH classified as GSW – Non-putrescible.

In order to provide VENM certification, appropriate segregation and validation of overlying fill and exceedances recorded in natural soil would need to be completed by an environmental consultant.

Appendix K

EPBC Act Protected Matters report

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 08-Jul-2022

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	7
Listed Threatened Species:	43
Listed Migratory Species:	13

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	10
Commonwealth Heritage Places:	None
Listed Marine Species:	19
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	7
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	1
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text	Buffer Status
Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion	Endangered	Community may occur within area	In feature area
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community may occur within area	In feature area
Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland	Endangered	Community likely to occur within area	In feature area
Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion	Critically Endangered	Community may occur within area	In feature area
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest	Critically Endangered	Community likely to occur within area	In feature area
River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria	Critically Endangered	Community likely to occur within area	In feature area
Western Sydney Dry Rainforest and Moist Woodland on Shale	Critically Endangered	Community may occur within area	In feature area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Anthochaera phrygia			
Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Callocephalon fimbriatum Gang-gang Cockatoo [768]	Endangered	Species or species habitat likely to occur within area	In feature area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat may occur within area	In feature area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area	In feature area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area	In buffer area only
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Pycnoptilus floccosus Pilotbird [525]	Vulnerable	Species or species habitat may occur within area	In feature area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area	In feature area
FISH			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Macquaria australasica			
Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area	In feature area
Prototroctes maraena			
Australian Grayling [26179]	Vulnerable	Species or species habitat may occur within area	In feature area
FROG			
Heleioporus australiacus			
Giant Burrowing Frog [1973]	Vulnerable	Species or species habitat may occur within area	In feature area
Litoria aurea			
Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat likely to occur within area	In feature area
MAMMAL			
Chalinolobus dwyeri			
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Dasyurus maculatus maculatus (SE mainland population)			
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area	In feature area
Petauroides volans			
Greater Glider (southern and central) [254]	Endangered	Species or species habitat may occur within area	In feature area
Petaurus australis australis			
Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Petrogale penicillata			
Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat may occur within area	In feature area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)			
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat known to occur within area	In feature area
Pseudomys novaehollandiae			
New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
PLANT			
Acacia bynoeana Bynoe's Wattle, Tiny Wattle [8575]	Vulnerable	Species or species habitat may occur within area	In feature area
Acacia pubescens Downy Wattle, Hairy Stemmed Wattle [18800]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Allocasuarina glareicola [21932]	Endangered	Species or species habitat likely to occur within area	In feature area
Genoplesium baueri Yellow Gnat-orchid, Bauer's Midge Orchid, Brittle Midge Orchid [7528]	Endangered	Species or species habitat may occur within area	In feature area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat may occur within area	In feature area
Melaleuca deanei Deane's Melaleuca [5818]	Vulnerable	Species or species habitat may occur within area	In feature area
Micromyrtus minutiflora [11485]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Persicaria elatior Knotweed, Tall Knotweed [5831]	Vulnerable	Species or species habitat may occur within area	In feature area
Persoonia hirsuta Hairy Geebung, Hairy Persoonia [19006]	Endangered	Species or species habitat likely to occur within area	In feature area
Persoonia nutans Nodding Geebung [18119]	Endangered	Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Pimelea spicata			
Spiked Rice-flower [20834]	Endangered	Species or species habitat likely to occur within area	In feature area
Pomaderris brunnea			
Rufous Pomaderris, Brown Pomaderris [16845]	Vulnerable	Species or species habitat may occur within area	In feature area
Pterostylis saxicola			
Sydney Plains Greenhood [64537]	Endangered	Species or species habitat may occur within area	In feature area
Pultenaea parviflora			
[19380]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Rhizanthella slateri			
Eastern Underground Orchid [11768]	Endangered	Species or species habitat may occur within area	In buffer area only
Rhodamnia rubescens			
Scrub Turpentine, Brown Malletwood [15763]	Critically Endangered	Species or species habitat may occur within area	In buffer area only
Syzygium paniculatum			
Magenta Lilly Pilly, Magenta Cherry, Daguba, Scrub Cherry, Creek Lilly Pilly, Brush Cherry [20307]	Vulnerable	Species or species habitat may occur within area	In feature area
Thesium australe			
Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat may occur within area	In feature area
REPTILE			
Delma impar			
Striped Legless Lizard, Striped Snake-lizard [1649]	Vulnerable	Species or species habitat may occur within area	In feature area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Terrestrial Species			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area	In feature area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat likely to occur within area	In feature area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area	In feature area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area	In feature area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area	In feature area
Migratory Wetlands Species			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Numenius madagascariensis			
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State	Buffer Status
Communications, Information Technology and the Arts - Australian Postal Corporation		
Commonwealth Land - Australian Postal Commission [12815]	NSW	In buffer area only
Defence		
Commonwealth Land - Defence Service Homes Corporation [12817]	NSW	In buffer area only
Commonwealth Land - Defence Service Homes Corporation [12816]	NSW	In buffer area only
Commonwealth Land - Defence Service Homes Corporation [12824]	NSW	In buffer area only
Defence - SIGNAL STRS DEPOT-KINGSWOOD [10209]	NSW	In buffer area only
Defence - SIGNAL STRS DEPOT-KINGSWOOD [10210]	NSW	In buffer area only
Defence - Defence Housing Authority		
Commonwealth Land - Defence Housing Authority [12823]	NSW	In buffer area only
Commonwealth Land - Director of War Service Homes [12847]	NSW	In buffer area only
Commonwealth Land - Director of War Service Homes [12826]	NSW	In buffer area only
Commonwealth Land - Director of War Service Homes [12825]	NSW	In feature area

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area	In feature area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat likely to occur within area overfly marine area	In feature area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area	In feature area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area overfly marine area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Merops ornatus			
Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
Monarcha melanopsis			
Black-faced Monarch [609]		Species or species habitat likely to occur within area overfly marine area	In feature area
Motacilla flava			
Yellow Wagtail [644]		Species or species habitat likely to occur within area overfly marine area	In feature area
Myiagra cyanoleuca			
Satin Flycatcher [612]		Species or species habitat known to occur within area overfly marine area	In feature area
Neophema chrysostoma			
Blue-winged Parrot [726]		Species or species habitat may occur within area overfly marine area	In feature area
Numenius madagascariensis			
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Rhipidura rufifrons			
Rufous Fantail [592]		Species or species habitat likely to occur within area overfly marine area	In feature area
Rostratula australis as Rostratula benghalensis (sensu lato)			
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area

Extra Information

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
Warragamba Dam Raising Project	2017/7940	Controlled Action	Assessment Approach	In feature area
Not controlled action				
Erection of a dwelling and associated access and infrastructure, 19 Tidswell Str	2003/1078	Not Controlled Action	Completed	In buffer area only
gas main installation from Eastern Creek to Erskine Park	2005/2235	Not Controlled Action	Completed	In feature area
hazard reduction burn	2003/1181	Not Controlled Action	Completed	In feature area
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area
Multi User Depot	2002/562	Not Controlled Action	Completed	In buffer area only
Not controlled action (particular manner)				
Replacement of flows with recycled water	2006/3050	Not Controlled Action (Particular Manner)	Post-Approval	In feature area

Bioregional Assessments

SubRegion	BioRegion	Website	Buffer Status
Sydney	Sydney Basin	BA website	In feature area

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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