sydney METRO | city & southwest

SYDENHAM TO BANKSTOWN

ENVIRONMENTAL IMPACT STATEMENT

> Volume 1C – Main Volume

NSW GOVERNMENT

Transport for NSW

Sydney Metro City & Southwest

Sydenham to Bankstown upgrade

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Sydenham to Bankstown Design Guidelines

NSW GOVERNMENT | Transport for NSW

Sydney Metro City & Southwest

Sydenham to Bankstown Design Guidelines

June 2017

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1 Introduction

1.1 Purpose of these Guidelines

The Guidelines will support the development of healthy, cohesive and inclusive communities.

The Guidelines establish the design approach for the Sydney Metro Sydenham to Bankstown upgrade (the project) by guiding the design of the interface between stations and their surrounding locality including:

- Station entries
- Transport interchange facilities (bicycle facilities, bus stops, kiss and ride, taxi ranks and connections to existing rail and light rail transport)
- Landscaping and other public domain elements
- Rail corridor works including rail cuttings and embankments
- Station and service buildings

Any development above or adjacent to Metro stations would be subject to a separate planning approval.

The Guidelines have been developed to respond to the strategic directions and urban design strategies of NSW Planning and Environment and local Councils. The Guidelines will be used by Transport for NSW (TfNSW) to guide the design development process for the project.

The Sydney Metro Delivery Office, part of TfNSW, is managing the planning, procurement and delivery of the Sydney Metro Network.

Cheltenham Station
Source: COX

1.2 Project Scope

The Sydney Metro City & Southwest Project will upgrade all ten stations between Sydenham to Bankstown to conform with current accessibility standards, before conversion to metro operations. The project will upgrade stations at;

- Marrickville
- Dulwich Hill
- Hurlstone Park
- Canterbury
- Campsie
- Belmore
- Lakemba
- Wiley Park
- Punchbowl
- Bankstown

The project will also convert two of the existing station platforms at Sydenham Station to metro operations.

Key Project features include:

- 13km upgrade of corridor and stations of the T3 Bankstown Line between Sydenham and Bankstown and their subsequent conversion to metro operations
- Fully accessible stations, with lifts and level access between trains and platforms
- Improved interchange with bus, light rail, pedestrian and cycling networks, and provision of taxi, kiss and ride and bike parking facilities at all stations
- Fast, safe and reliable – a new generation of 21st century metro trains.

Sydney Metro Sydenham to Bankstown Alignment

1.3 Project Vision

Transport for NSW's vision for Sydney Metro is:

"Transforming Sydney with a new world class metro".

The Sydney Metro Delivery Office's mission is to deliver a world class, connected metro, which will provide more choice to customers and opportunities for our communities now and in the future.

Sydney Metro is also a unique opportunity to demonstrate an exemplary approach to station and precinct design and foster exemplary urban design, integrated transport and land use planning. Quality architecture, good urban design and a user friendly and inter-connected transport system are critical to ensuring that the Sydney Metro project meets customer needs and expectations and maximises its city shaping potential and broader urban benefits.

Cherrybrook Station, artists impression
Source: TfNSW

1.4 Design Objectives

To help meet the transformational vision and world class aspirations of the project, five **Design Objectives** for the project have been agreed to guide decision making and the design process for the City & Southwest project.

A **Design Principle** is prescribed under each design objective, describing the intention of the objective for the design of stations, station precincts and the wider Metro corridor:

Objective 1: Ensuring an easy customer experience.

Principle
Sydney Metro places the customer first. Stations are welcoming and intuitive with simple, uncluttered spaces that ensure a comfortable, enjoyable and safe experience for a diverse range of customers.

Objective 2: Being part of a fully integrated transport system.

Principle
Sydney Metro is a transit-oriented project that prioritises clear and legible connections with other public and active transport modes within the wider metropolitan travel network that intersect with this new spine.

Objective 3: Being a catalyst for positive change.

Principle
Sydney Metro is a landmark opportunity to regenerate and invigorate the city with new stations and associated development that engage with their precincts, raise the urban quality and enhance the overall experience of the city.

Objective 4: Being responsive to distinct contexts and communities.

Principle
Sydney Metro's identity is stronger for the unique conditions of centres and communities through which it passes. This local character is to be embraced through internationally benchmarked high quality station architecture and public domain that is well integrated with the valuable inherited urban fabric of existing places.

Objective 5: Delivering an enduring and sustainable legacy for Sydney.

Principle
Sydney Metro is a positive legacy that demonstrates excellent and enduring design quality for future generations. A high standard of design across the corridor, stations and station precincts, that sets a new benchmark, is vital to ensuring the longevity of the Metro system, its enduring contribution to civic life and an ability to adapt to a changing city over time.

Sydney Metro places the customer first.
Source: TfNSW

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1.5 Understanding Customer Needs

Customer Centred Design

At Sydney Metro we aim to serve a diverse set of customers who will undertake a number of journeys throughout the day and week using our Metro. The design and delivery of service is centred around the customer – their needs, behaviours, and jobs to be done (tasks they want to achieve using the service).

Our commitment is to deliver a reliable "door-to-door-to-door" transport solution that is surprisingly easy for all our customers by the delivery of a thoughtfully designed, seamlessly integrated experience that moves customers around quickly and easily and is adaptive to change. Providing services centred around the customer is key to Sydney Metro's ongoing success and building a solid customer base.

Our customer experience target

Sydney Metro customer experience pyramid
Source: TfNSW

At a very basic level our customers expect Sydney Metro to provide a service that is on time, clean, safe, comfortable, efficient, and convenient, has the right information, and has adequate customer service. These basics are key drivers of customer satisfaction.

Our goal is to deliver a level of service that goes beyond satisfaction and makes it easy for customers to use the Metro and encourages repeat use across the multiple types of journeys they may make. This will endeavour to support TfNSW's goal of increasing the number of journeys taken on public transport by the public both in the peak and off peak.

Designing for an easy customer experience is an important part of engaging customers to use Sydney Metro as part of their journey. Customers will expect more from our service over time and ease of use is the foundation for design and development of all our products, services, systems and spaces going forward.

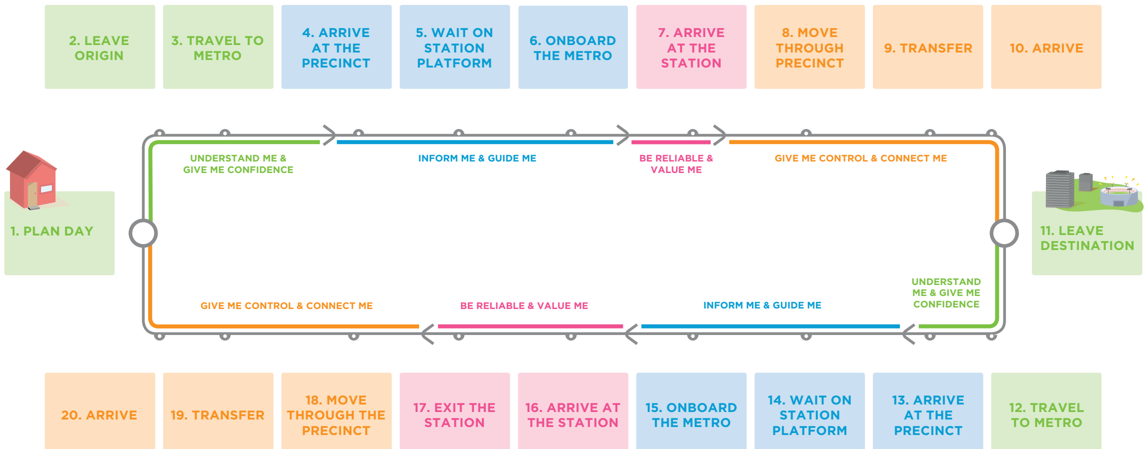
An integrated customer journey - 'door-to-door-to-door'

Customers see their journey from door-to-door-to-door (from origin to destination and back again) and may plan and utilise multiple travel modes throughout their journey in order to achieve their job to be done. It is critical to customers that their journey is seamless and well integrated across all connecting modes and that there is easy access to connect to the Metro.

A customers' ideal journey starts at their origin when they are planning their day. At this point they decide whether they travel with Sydney Metro or not. The information about all our modes and connection with Metro systems and services will be key in enabling customers to make a choice to use us. If a customer cannot easily see how they can leave their origin, get to their destination and then return or do another onward journey – they are less likely to engage with Sydney Metro as part of their journey.

At each stage of the journey there are a number of touchpoints where the customer will interact with a TfNSW product, service, system or is interacting in one of our spaces such as a precinct or an interchange or using one of our modes. At these touchpoints we aim to make it easy to interact as well as provide consistency in service delivery and information such that it is easy for a customer to have a seamless journey from door to door.

The customer journey map diagram captures the touchpoints in a customer's ideal journey door (origin – planning the day) to door (destination) to door (return to origin). Key elements that are important to customers have been noted at each touchpoint. We need to make sure that these elements are well understood so we can deliver a product and service that matches customer needs



Sydney Metro customer journey map
Source: TfNSW

Sydney Metro Easy Customer Principles

The Sydney Metro Customer Principles are to be used to guide the design, development and operation of the services, products, systems and spaces to enable customers to have an easy customer experience. They outline:

What customers need:

- Understand Me – means demonstrating awareness and appreciation of my requirements for certainty, safety and value by providing me with easy and effective transport experiences that match my specific needs and wants.
- Give Me Confidence – means providing me with a clear appreciation for the integrated service offerings available through Sydney Metro. Assure me that throughout the journey that I can trust Sydney Metro to provide dependable, safe and secure solutions that will meet my particular needs whilst getting me to my destination in time and home again comfortably.

What the service must offer:

- Inform Me – means providing me with easy access to clear, accurate, relevant and up-to-date information at appropriate times and through convenient channels that enables me to plan my day, execute my plans and share details with others so I can easily achieve my goals with the least amount of effort, confusion and with minimal disruption.
- Guide Me – means showing me the best way to get to where I want to go, in order to get there in time, with the least amount of frustration, stress or uncertainty by directing, instructing and managing flow, crowding or impediments. It also means helping me resolve any problems or difficulties I might encounter that might negatively impact my overall experience.

How the organisation must deliver it:

- Be Reliable – means providing an effective frequency of integrated services that meet my specific needs, whilst dependably collecting and delivering me at scheduled times that enable me to successfully manage my commitments and run my life.
- Value Me – means providing effective transport solutions that I can access with the minimum amount of effort, at the right times and through convenient channels that truly respects my time. In addition, my safety, security, health and wellbeing are all considered and provided for in the way the services are delivered.

How customers want to feel:

- Give Me Control – means empowering me with the necessary knowledge and ability to make choices. It means reducing uncertainty and stress by allowing me to play an active role in managing my situation. Providing advance notice of problems with guidance and real-time updates that keep me informed gives me the freedom to update arrangements with others that may be impacted by the situation.
- Connect Me – means bringing customers closer to the people and things that are most important to them. A more effective transport solution provides a vital contribution to meeting customers' interpersonal needs including a sense of belonging, self-esteem, friendship, love and security. Being connected is an integral enabler and a key component of the broader community experience.

Sydney Metro Customer Principles
Source: TfNSW

1.6 A Commitment to Safety

Transport for NSW is committed to ensuring Sydney Metro is designed, constructed and operated in a manner that facilitates safe working and customer passage. The project will provide facilities for customers, staff and contractors that meet or exceed any required safety standards. Sydney Metro will also comply with all relevant statutory and regulatory requirements in respect of safe system design, delivery and operation.

Safety will be considered at all stages of design across all aspects of corridor and station planning, construction, operation and maintenance. In particular, the design of Metro infrastructure in the city must provide safe interfaces between stations and the existing urban environment. The safe movement of customers, staff and contractors through station areas needs to be facilitated through many aspects of physical design, including provision of adequate platform capacity and circulation space, clear routes, adequate lighting and slip resistant flooring, as well as by minimising obstructions and eliminating crush zones.

Station and station realm design will identify and reflect current architectural and engineering best practice with respect to safety. Guidelines and protocols, such as Crime Prevention Through Environmental Design (CPTED), will also be important benchmarks in minimising the risks of personal harm, operational disruption and conflict.

Construction and operational safety will be managed through a rigorous safety in design process which will identify, develop and implement safety controls, and enhance the construction, operational and maintenance outcomes.

Maintenance and asset management strategies will be adopted that reduce risk through safety auditing and reporting. Sydney Metro will have a comprehensive framework to avoid or minimise risk, and to enhance safety, without unreasonably reducing amenity and functionality.

Construction of Sydney Metro Northwest.
Source: TfNSW

1.7 A Commitment to Sustainability

Transport for NSW has a clear vision for Sydney Metro to achieve new benchmarks in sustainable infrastructure delivery. This means demonstrating that Sydney Metro is at the forefront of best practice, delivering environmental, social and economic improvements throughout the delivery and operational phases of the project.

This commitment is articulated through a strategic Sydney Metro objective to deliver a sustainable metro product which contributes to environmental, social and economic sustainability and the project Environment and Sustainability Policy which contains specific sustainability objectives. Sustainability objectives relevant to these design guidelines are presented in the table below.

Microclimate and customer comfort can be improved through the use of landscaping and appropriate shading and weather protection.
Source: AECOM.

Governance	Demonstrate leadership by embedding sustainability objectives into decision making
	Demonstrate a high level of performance against objectives and appropriate benchmarks
Carbon & Energy Management	Improve the shift toward lower carbon transport
	Reduce energy use and carbon emissions during operations
	Support innovative and cost effective approaches to energy efficiency, low-carbon / renewable energy sources and energy procurement
Pollution Control	Reduce sources of pollution and optimise control at source to avoid environmental harm
Climate Change Resilience	Infrastructure and operations will be resilient to the impacts of climate change
Resources - Water Efficiency	Minimise use of potable water
	Maximise opportunities for reuse of rainwater, stormwater, wastewater and groundwater
Resources - Waste & Materials	Minimise waste through the project lifecycle
	Reduce materials consumption
	Consider embodied impacts in materials selection
	Maximise beneficial reuse of spoil
Biodiversity Conservation	Protect and create biodiversity through appropriate planning, management
Heritage Conservation	Protect and promote heritage through appropriate design, planning, and management controls
Liveability	Promote improved public transport patronage by maximising connectivity and interchange capabilities
	Provide well designed stations and precincts that are comfortable, accessible, safe and attractive.
Community Benefit	Make a positive contribution to community health and well-being
	Ensure community and local stakeholder engagement and involvement in the development of the project
	Contribute to the delivery of legacy projects to benefit local communities
	Optimise community benefit of residual land development

1.8 Structure of the Guidelines

The Design Guidelines are structured into four sections:

1. Introduction (this part)

Provides an overview of the Sydney Metro City & Southwest, the project objectives, design principles, an understanding of our customers' needs and the importance of design in meeting those needs.

2. Stations

Outlines the key contextual factors and design drivers that impact the design of the station and surrounding environment.

3. Function & Experience

Outlines the principles and design guidelines to be applied to the design strategies for stations and their interface with adjoining areas.

4. Elements

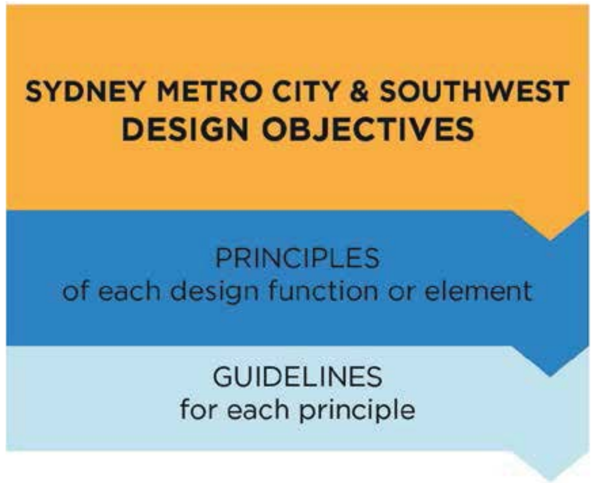
Outlines the principles and design guidelines to be applied to the elements of the new stations and their interface with adjoining areas.

Document Structure
Sections 3 and 4 are structured to include:

Relevant Design Objectives - how each design guideline relates to the project Design Objectives.

Principle - of each design element.

Guidelines - describes best practice design responses that address the objective.



1.9 Application of the Guidelines

Review of Design
The design of Sydney Metro is subject to ongoing internal review processes to ensure the designs are developed to respond to these Guidelines. This will ensure design quality meets the needs and expectations of Sydney Metro customers and the people of NSW. These Guidelines will be kept under review through subsequent detailed design and procurement stages to ensure that they remain up to date and relevant.

The design of Sydney Metro and implementation of these Guidelines is also subject to independent review by the Sydney Metro Design Review Panel. The Design Review Panel provides independent, high-level design review of the project to support the achievement of Sydney Metro project objectives and ensure quality design outcomes.

The Design Review Panel is chaired by the NSW Government Architect and is supported by suitably qualified and appropriately skilled professionals from the fields of architecture, urban design, landscape design and heritage architecture. The Design Review Panel is supported by specialist advisers in the fields of community integration, transport integration, sustainability and cultural heritage, as required.

These panel members will provide independent design review and advice periodically throughout the development of the design. They will maintain an ongoing review role in the design process for the project, ensuring that as the design of individual components develops, it delivers on the principles contained within this document.

Updating the Guidelines
These Guidelines will be reviewed and updated following exhibition of the Sydenham to Bankstown EIS. The Guidelines may be updated from time to time through the project delivery stage, including application of the Guidelines in relevant contracts. It is envisaged that future updates would provide additional detail and guidance as design progresses. The objectives and principles contained in this version of the document would continue to apply in subsequent versions. Updated versions of the Guidelines would be subject to the review and endorsement of the Design Review Panel.

Artists rendering of Cudgegong Road station, Sydney Metro Northwest.
Source: TfNSW

2 Stations

About this Section

This section describes the context and functional character of the Sydney Metro stations. It acknowledges the existing conditions and urban interfaces of each station in order to inform the delivery of contextually responsive and integrated environmental outcomes.

The urban and public domain design must be developed with reference to the existing urban context and infrastructure (including built form and public domain conditions, landscape elements and existing and proposed services) as well as planned initiatives in the locality.

New metro stations are proposed at:

- Marrickville
- Dulwich Hill
- Hurlstone Park
- Canterbury
- Campsie
- Belmore
- Lakemba
- Wiley Park
- Punchbowl
- Bankstown

Sydney Metro Sydenham to Bankstown Alignment

2.1 Corridor

Bankstown Line Heritage Summary
The Bankstown Line was built in three primary stages between 1895 and 1917:

- 1895 Belmore Branch Line - Sydenham to Belmore
- 1909 Bankstown Extension - Belmore to Bankstown
- 1917 Metropolitan Goods Line - Belmore Triangle to Sydenham

The opening of the various Bankstown Line stations was the primary catalyst for suburban development along the corridor. Colonial era land grants were subdivided as the stations were built, with the earliest development often focused on station entrances and the rail alignment.

The stations are variously listed on three Registers; the State Heritage Register; the S170 Heritage and Conservation Register; and the Local Register.

Sydney Metro's heritage philosophy is to:

- Recognise and demonstrate the heritage significance of all phases of rail transport development along the Line;
- Retain and conserve, wherever possible, elements of heritage significance; and
- Remove intrusive station elements that detract from the core heritage values.

Corridor Design Philosophy
The design of Sydney Metro Southwest will draw on the landscapes and heritage, the cultural history and the communities of the Bankstown Line, revealing and enhancing the qualities of these places, making new connections between communities and contributing to the regeneration of town centres.

Sydney Metro will provide an efficient and easy travelling experience as part of an integrated transport system - a contemporary, sustainable system that will leave an enduring legacy for Sydney.

Three Corrridor Themes have been identified that address the project Design Objectives:

- Re-discovery
- Re-connection
- Re-generation

RE-DISCOVER

The notion of rediscovering existing qualities found in the Bankstown corridor reflects a number of the project design objectives.

Two of its primary qualities are the heritage fabric of the line itself and the diversity of its centres and communities. A design that is responsive to this context, that reveals and re-purposes heritage buildings and structures, adds a new layer of high quality architecture and new public spaces attuned to local settings, will be a catalyst for wider urban renewal but also deliver an important public legacy for southwest Sydney.

- Conserve and re-use heritage fabric wherever possible
- Utilise locally responsive design to express unique community characteristics, through public art, community facilities and new physical links across the corridor
- Build on the landscape character of the corridor, and identify wider connections to green spaces
- Enable the cultural diversity across the corridor that has come about with successive waves of migrants to thrive, but using social life as the generative point of design

RE-CONNECT

Renewal of the corridor allows for the creation of a more integrated transport system and an enhanced customer experience for users.

Easy, accessible interchange between modes will be designed in, while improved walking and cycling facilities at, and between, stations will prioritise these modes. New links to town centres, across the corridor and from station to station will better connect communities and build on existing landscape and open space qualities.

Considered integration of the new will ultimately build a durable project legacy.

- Create identifiable and legible new stations within existing contexts, with easy connections to interchange points and the surrounding fine grain street networks
- Ensure a reliable and comfortable customer experience in and around station precincts, with efficient transfers between modes and a high level of urban amenity
- Build on the existing landscape character of the corridor, connecting corridor landscaping to adjacent landscapes
- Integrate disconnected areas of open space around stations, providing clearer links across the wider network

RE-GENERATE

Updating the Sydenham to Bankstown line to contemporary standards will be a critical catalyst for the 11 town centres of the corridor.

Thoughtful integration with existing landscape areas and provision of new links will foster connection and ease of travel in the region and locally.

Adding public spaces and public architecture of quality to town centres will be an important broader legacy of the project.

- Expand and enhance the existing vegetation along the corridor, building on adjacent roadway plantings and protecting endangered species.
- Establish and expand cross corridor green connections, building on the wider green grid network and enhancing opportunities for active transport and recreation
- Design for drought resilience and low maintenance, using endemic species where appropriate
- Rejuvenate local centres using Sydney Metro as the catalyst for change

2.2 Marrickville

Centre type: Local Centre

Primary Function: Origin

Catchment: Residential and retail

Local Government Area: Inner West Council

Station & Platform Type: Surface, side platform

Context
Marrickville is located 7km south-west of Sydney CBD and is the largest suburb in the Inner West Council (formerly Marrickville) Local Government Area. The suburb lies between Stanmore, Enmore, Newtown, St Peters, Sydenham, Tempe, Dulwich Hill, Hurlstone Park and Petersham.

The primary station entry is on Illawarra Road, a largely retail strip in the section between Warren Road and Marrickville Road. Some larger, multi-storey apartment buildings occur on Illawarra Road along with a significant number of shop-top housing developments. Back from the high street the southern part of Marrickville is generally a low-rise residential neighbourhood.

A secondary entry at platform level occurs on Station Street, adjacent to the country bound platform. Small apartment buildings and retail outlets characterise the Station Street block. Further to the east in the Carrington Road precinct, industrial land uses predominate.

Marrickville is listed on the State Heritage Register.

Key design drivers:
- Integration of a contemporary Metro station into an urban context characterised by the diversity of its building form.
- Improvements to pedestrian connectivity and safety in the precinct through dedicated crossings, improved pathways and a shared zone adjacent to the station.
- Enhancement of interchange provision through the addition of accessible taxi, kiss & ride and accessible parking bays, and secure bicycle parking facilities.

Existing Station Street entry
Source: COX/HASSELL

Existing Marrickville Station platform building
Source: COX/HASSELL

Cafe at Warburton Street
Source: COX/HASSELL

Street art at existing station
Source: COX/HASSELL

Landscape and Urban Character

The low-lying land of the Gumbramorra Swamp once defined the Marrickville area, along with dense woodlands and the sandstone ridgelines of the valley. The clay loam soils of the area proved to be fertile soils for market gardening and later as the source material for the brick making industry that arose in the 1880s. By the 1920s and 1930s the clay had run out and Marrickville Council had resumed most of the brick pits for public parks.

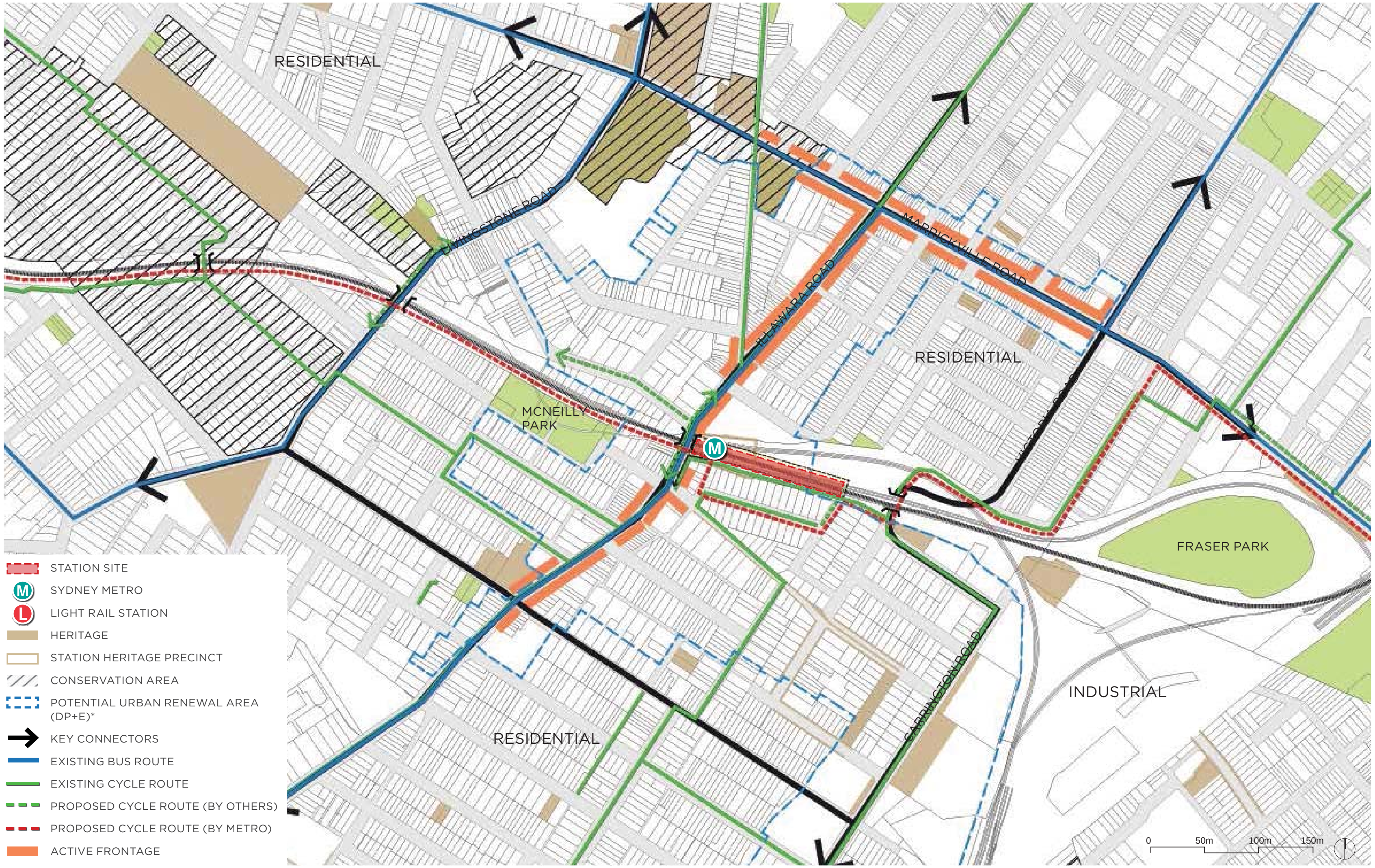
The industrial legacy is still very apparent, especially in eastern sections of the suburb where the landscape is distinctly commercial and industrial.

Residential areas are a mix of Victorian era terrace housing, Federation bungalows and a range of twentieth century building types, up to and including recent multi-storey apartment buildings.

There are extensive retail/commercial strips along Illawarra and Marrickville which combine to form one of the longest main streets in Sydney.

The rail corridor divides the precinct in two and restricts north-south movement. The main commercial strip is defined by traditional, fine grain, built form with 1–2 storey high street buildings of varying quality and a mix of newer, larger infill buildings. The recently completed seven storey mixed use development, north of the station, helps define the station precinct.

McNeilly Park, Marrickville
Source: COX/HASSELL



Marrickville Station Local Context Plan

* Source: Sydenham to Bankstown Urban Renewal Corridor Strategy 2015

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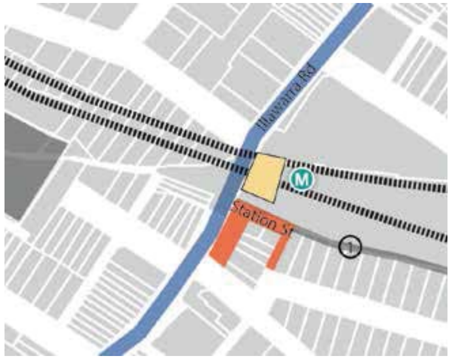

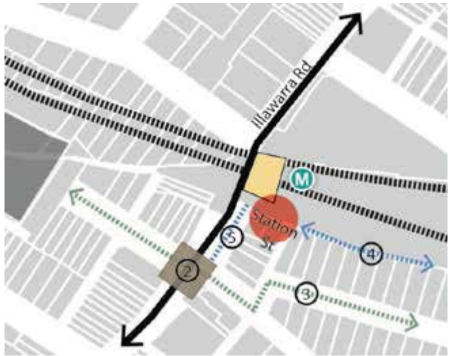

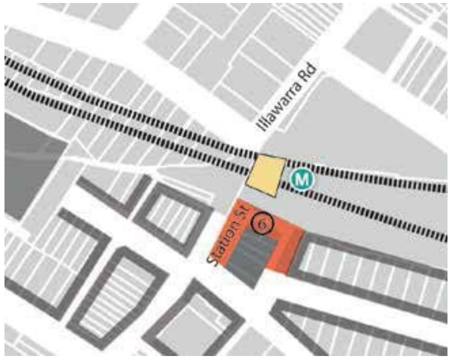

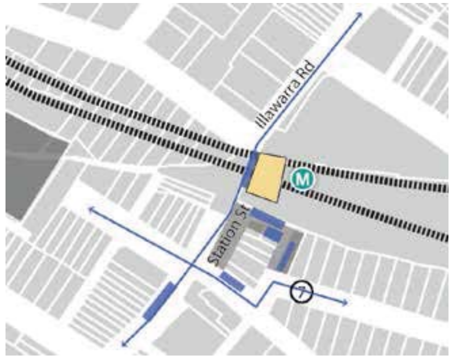

Marrickville Urban Design Strategies

Local public domain

- Station Street plaza/shared zone will add a new, intimate public space to the public domain of the Illawarra Road precinct.
- Renewal of the southern access path and the Station Street shared zone will improve the station interface with local streets. 1

Connectivity and access

- Improvements to crossing conditions at Illawarra Road, Schwebel and Warburton Streets facilitates better connectivity. 2
- Proposed cycle route as part of active transport corridor: on Leofrene Avenue, through Station Street shared zone, below Illawarra Road and westwards in corridor. 3
- Southern station access path upgrade to improve access to the station from the east. 4
- Improve accessibility on Station Street (west) to overcome non-compliant grade. 5

Catalyst

- Marrickville Metro station and associated public space is the potential nexus for adjacent redevelopment.
- Station Street plaza/shared zone creates an intimate public space away from the high street. 6

Accessible interchange

- Secure and sheltered bicycle parking.
- Taxi and kiss and ride bays in Station Street shared zone.
- Accessible ramp on Station Street (west) to provide an accessible path to Illawarra Road northbound bus stop and Schwebel Street accessible parking bays.
- Cycle route on Leofrene Avenue, through Station Street shared zone, below Illawarra Road and in corridor west of Station Street. 7

2.3 Dulwich Hill

Centre type: Local Centre

Primary Function: Origin

Catchment: Residential

Local Government Area: Inner West Council

Station & Platform Type: Surface in cutting, island platform

Context

Dulwich Hill is located 8km south-west of Sydney CBD and is located in the Inner West (formerly Marrickville) Local Government Area. The suburb is bounded by Marrickville to the east, Hurlstone Park to the west, New Canterbury Road to the north and Cooks River to the south.

The area around the station is a mixture of single storey housing and 2-3 storey apartment blocks. In recent years a handful of taller shop-top housing developments have been added to the existing Wardell Road strip of retail and small commercial buildings. The area has a relatively coherent urban form that includes a large Heritage Conservation Area southeast of the station. The existing station entry is on the Wardell Road overbridge and the Inner West Light Rail terminus is accessed from Bedford Crescent on the northern side of the heavy rail station.

Key design drivers:

- Relocation of the station concourse to the west allows retention of the heritage platform building.
- New concourse to serve both the Metro station and the Inner West Light Rail terminus to assist efficient interchange.
- Utilise available land south of the station for a generous public space while Bedford Crescent north of the station becomes a fully accessible interchange zone.

Dulwich Hill platform
Author: Gareth Edwards

Street art along the existing cycle route at Dulwich Hill
Source: COX/HASSELL

Dulwich Hill Light Rail Station entrance
Source: COX/HASSELL

Dulwich Hill houses
Source: Walk Sydney Streets

Landscape and Urban Character

Dulwich Hill Village includes a small group of shops directly adjacent to the station while the larger Dulwich Hill town centre is on Marrickville Road and New Canterbury Road. This primary commercial and retail area is located approximately 800m north of the station.

The station village extends for a single block to the north and south. The village generally has a traditional 2 storey high street elevation, with a handful of taller mixed use buildings.

Low vehicle speeds and the relatively narrow carriageway along Wardell Road makes for an attractive public domain for pedestrians, even though the street gradient is steep. The station area is surrounded by a zone of medium density walk-up residential buildings, primarily to the south of the station.

Beyond this area, the residential streets are characterised by single detached houses on relatively compact lots, generally dating from the early-20th century. The streets are relatively wide with nature strips, street trees and footpaths. Some streets, such as Ness Avenue and Albermarle Street have distinctive brick paved footpaths that date from the Depression of the 1930s.

Tom Kenny Reserve in Bayley Street and Jack Shanahan Park, adjacent to the Light Rail provide public open space in the wider station precinct.

Dulwich Hill Village Fair
Source: Your Say Inner West

Dulwich Hill Station Local Context Plan

* Source: Sydenham to Bankstown Urban Renewal Corridor Strategy 2015

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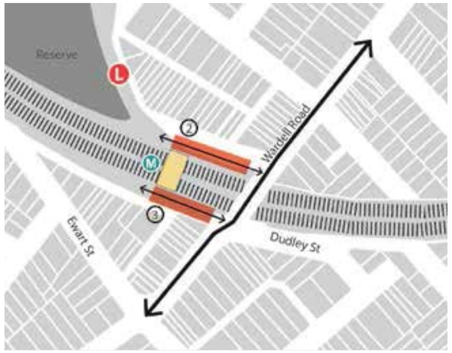

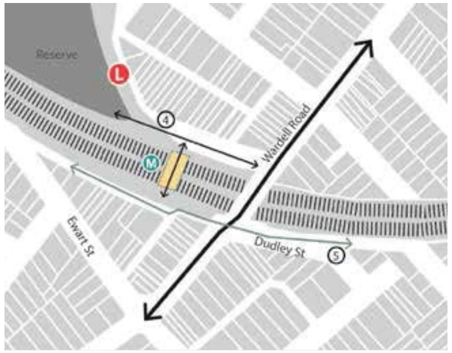

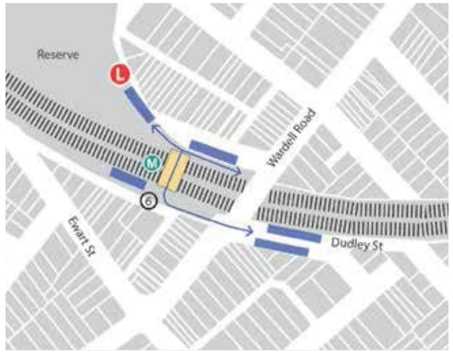

Dulwich Hill Urban Design Strategies

Station and Public Space as Catalyst

- Broad public connections to new station concourse.
- Improved public domain has potential to generate wider precinct improvements.
- Southern plaza as catalyst for adjacent north facing development sites. 1

Public Domain

- Generous pedestrian / interchange zone north of station. 2
- Generous terraced plaza and shared zone to south of station. 3

Connectivity

- New Opal enabled cross-corridor connection.
- Accessible approaches to station.
- Improved link to light rail terminus and Jack Shanahan Park. 4
- Upgrade cycleway through station precinct as part of the proposed Southwest active transport corridor. 5

Accessible Interchange

- At grade accessible connection between interchange zone and station concourse.
- Lift from concourse to light rail terminus.
- Accessible path from station plaza to Wardell Road crossing.
- Secure and sheltered bicycle parking in station plaza. 6

2.4 Hurlstone Park

Centre type: Local Centre

Primary Function: Origin

Catchment: Residential and retail

Local Government Area: City of Canterbury Bankstown

Station & Platform Type: Surface in cutting, side platform

Context

Hurlstone Park Station is located approximately 8.5km south-west of the Sydney CBD in the City of Canterbury- Bankstown. The suburb is bordered by Dulwich Hill to the north and east, Earlwood to the south and Canterbury to the west. The existing station on the overbridge is immediately before the small strip shopping centre further north on Crinan Street.

The village centre is largely low scale retail and residential buildings. Beyond Crinan Street, the built form is generally single or two-storey detached housing dating to the early twentieth century. There is also a grouping of later walk up apartment blocks north of the station.

Key design drivers:

- Maintenance of the traditional station address as a local landmark at the centre of the village.
- Maintenance of the station entry on the high street overbridge, adjacent to existing bus stops.
- Improvements to the public domain around station, including connections to the Crinan Street retail centre and to the proposed interchange zone.

Excavated sandstone cutting on Platform 2
Source: COX/HASSELL

Hurlstone Park Station
Source: COX/HASSELL

Crinan Street, Dulwich Hill
Source: COX/HASSELL

Mural on overbridge
Source: COX/HASSELL

Landscape and Urban Character

Hurlstone Park is predominantly residential in nature. The small row of local shops along Crinan Street forms the village centre. Significant other commercial activities are centred on the Canterbury Road and New Canterbury Road intersection to the north. The Cooks River forms the southern boundary of the precinct.

The village centre has a traditional, fine grain built form with 1–2 storey high street buildings. The centre has a consistent form created by building height and street width proportions. Together with its low vehicular speed and narrow carriageway, Crinan Street provides a comfortable and attractive public domain for pedestrians.

A small area of medium density walk-up buildings are located primarily to the north of the railway station. These buildings are a mixture of strata-title and freehold. The surrounding residential areas are largely occupied by single detached houses on relatively compact lots dating from around the early-20th century. Building stock is generally in good condition.

Hurlstone Park Wanderers
Source: Hurlstone Park Wanderers

Hurlstone Park Station Local Context Plan

* Source: Sydenham to Bankstown Urban Renewal Corridor Strategy 2015

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Hurlstone Park Urban Design Strategies

Station and Public Space as Local Catalyst

- Station forecourt/plaza adds a central meeting space in the Hurlstone Park village. 1
- Improved public domain has the potential to generate wider streetscape improvements in the retail village and tie into the traditional character of the centre.

Public Domain

- Enlarged station forecourt doubling as a new local square. 2
- Kerb outstand at overbridge crossing to improve sightlines.
- New crossings on Duntroon Street (south) and Crinan Street (north) to improve pedestrian safety and amenity.

Connectivity

- Improved pathways and crossing conditions for pedestrians on both sides of the station.
- Accessible approach on southern side of station. 3
- Potential active transport connection in corridor east of the station and on-road west of the station. 4

Accessible Interchange

- At-grade accessible connection between Duntroon Street interchange zone and station entry.
- Accessible path to bus stops from station entry.
- Secured and sheltered bicycle parking.

2.5 Canterbury

Centre type: Local Centre

Primary Function: Origin

Catchment: Residential

Local Government Area: City of Canterbury Bankstown

Station & Platform Type: Surface in cutting, side platform

Context

Canterbury is located 10.5km south-west of Sydney CBD and is located in the City of Canterbury-Bankstown. The suburb closely borders the Cooks River to the south and is bisected by Canterbury Road. Earlwood lies south of the river, Hurlstone Park to the east, Campsie to the west and Ashbury to the north. The rail corridor and Canterbury Road limit pedestrian and cycle connectivity in the Canterbury Town Centre and the station precinct, in particular restricting connections to the Cooks River from the north.

The precinct north of the station is largely detached housing of the federation and Inter-war periods. South of the station a former industrial area has become a multi-storey residential zone with some ground floor retail. Further development of this type is anticipated east and north of the station and along Canterbury Road itself. Canterbury-Bankstown Council and Department of Planning and Environment are promoting the development of a new town centre to the west of Canterbury Road.

The station entry is currently on Canterbury Road where heavy vehicle traffic and extended clearways create a challenging pedestrian environment.

Key design drivers:

- A new station address aligned to changes in the local development pattern, whereby a new town centre is developing west of Canterbury Road.
- Station entries and plaza areas designed to improve pedestrian amenity and interchange efficiency.
- Improved north-south connectivity in the Canterbury urban renewal area.

Existing Platform building, Canterbury Station
Source: COX/HASSELL

Canterbury Club Hotel, Canterbury Road
Source: COX/HASSELL

Canterbury Racecourse
Source: Australian Turf Club

Platform 2 and recent development adjacent
Source: COX/HASSELL

Landscape and Urban Character

The key features of the Canterbury precinct are the Cooks River which runs through the middle of the precinct and the 35ha Canterbury Park Racecourse.

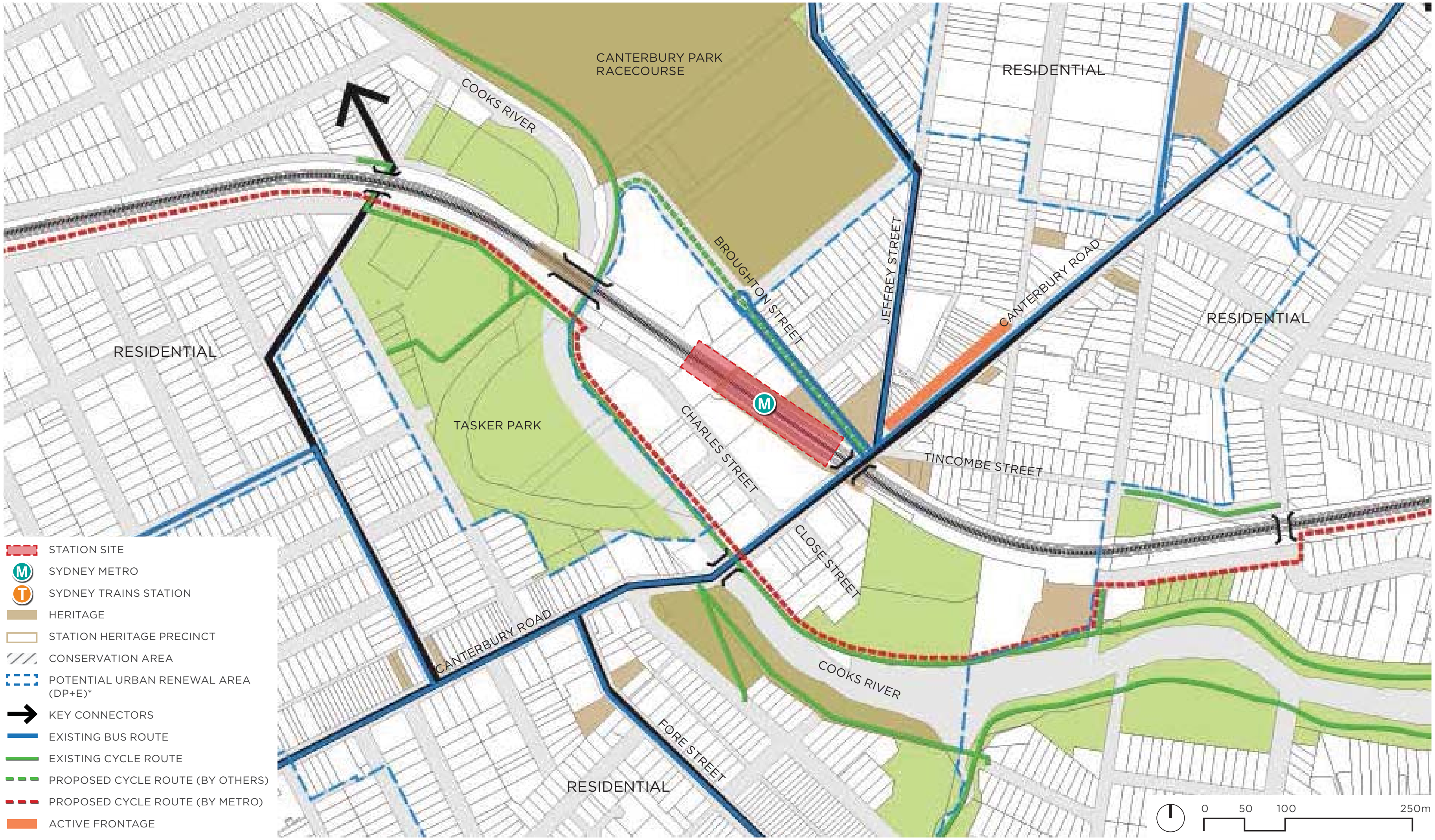
Canterbury has a linear, small business zoned centre focused along Canterbury Road and Broughton/Jeffery Street. The Cooks River and rail corridor divide the centre from the areas to the south.

The centre generally has a remnant of a fine grain, built form with 1–2 storey high street buildings along Canterbury Road. However, traffic volumes and car parking restrictions means this no longer functions as a retail street. A large supermarket complex is located off Jeffrey Street, behind the commercial strip.

Former industrial land immediately south and west of the station has been developed in recent years for mixed use and higher density residential uses. These precincts feature larger, perimeter block buildings of up to 12 storeys in height.

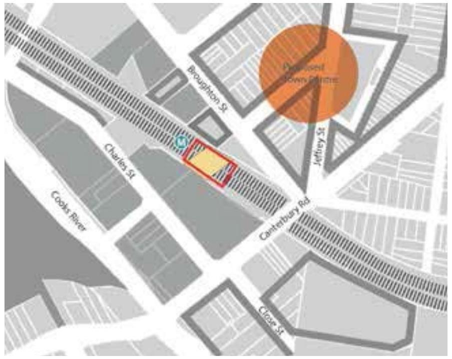
Building stock is generally in average to good condition, however a number of shop fronts along Canterbury are vacant and in poor condition awaiting redevelopment.

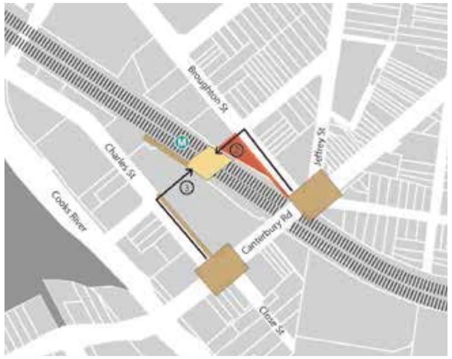
Cooks River
Source: City of Canterbury

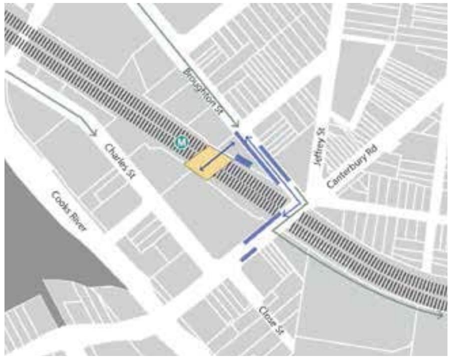


Canterbury Station Local Context Plan

* Source: Sydenham to Bankstown Urban Renewal Corridor Strategy 2015







Canterbury Station Urban Design Strategies

New Canterbury Town Centre

- Canterbury-Bankstown Council and Department of Planning and Environment led promotion of a new town centre to the west of Canterbury Road precinct.
- Completion of foreshadowed development south of the rail line.

Connectivity and Access

- Station concourse provides a new (Opal enabled) cross-corridor connection between the prospective new town centre and the southern urban renewal area and the Cooks River, as well as to the bus interchange zone on Canterbury Road. 1
- Council proposed signalisation of Charles and Close Streets/Canterbury Road intersection will improve east-west connectivity.

Public Space and Pedestrian Amenity

- Proposed interchange plaza on Broughton Street will create a comfortable, attractive public forecourt to the station. 2
- New entry south of the station. 3

Accessible Interchange

- Broughton Street interchange plaza will provide comfortable, accessible connections to bus stops, taxi and kiss and ride bays, and accessible parking.
- Southern entry arrangement will provide an accessible path back to city bound Canterbury Road bus stops.
- Subject to provision of a lift at Charles Street, the existing access easement will connect to Charles Street.
- Secure bicycle parking.

2.6 Campsie

Centre type: District Centre

Primary Function: Origin

Catchment: Residential, retail, civic, interchange

Local Government Area: City of Canterbury Bankstown

Station & Platform Type: Surface in cutting, side platform

Context

Campsie Station lies approximately 13km south-west of the Sydney CBD. Campsie falls within the City of Canterbury-Bankstown (formerly Canterbury) Local Government Area. The suburb is bounded by Belfield to the north, the Cooks River to the east, Clemton Park to the south and Belmore to the west. The busy retail spine of Beamish Street runs through the centre of Campsie, a suburb that is otherwise largely residential.

The housing stock is generally a mixture of detached housing and 2-3 storey apartment blocks. Recently, more intense development has begun to emerge in the vicinity of the station. The former City of Canterbury chambers are located north of the station on Beamish Street while important local public spaces – Anzac and Carrington Squares – are found immediately southwest of the station.

The concourse at Campsie Station directly abuts the Beamish Street road bridge with the concourse retail and station buildings aligned to the Beamish Street building line. Entry to the station is from the narrow Beamish Street footpath only. The station was the subject of an upgrade in 2002 that extended the station concourse, renewed amenities and retail outlets and provided lift access to station platforms.

Key design drivers:

- Retention of primary station address and entry on Beamish Street to maintain the urban pattern/street wall.
- Creation of a generous station forecourt and a shared zone on Lilian Lane to relieve congestion and improve the public domain.
- Secondary entry on North Parade to allow accessible connections to taxis and bus services.

Entry to Station from Beamish Street
Source: COX/HASSELL

ARTC freight line, Campsie
Source: COX/HASSELL

ANZAC Square, Campsie
Source: COX/HASSELL

Campsie Centre
Source: COX/HASSELL

Landscape and Urban Character

The Campsie town centre comprises a commercial strip running in a north-south direction along Beamish Street. The precinct contains a large variety of shops, civic and community services supporting the needs of the surrounding suburbs.

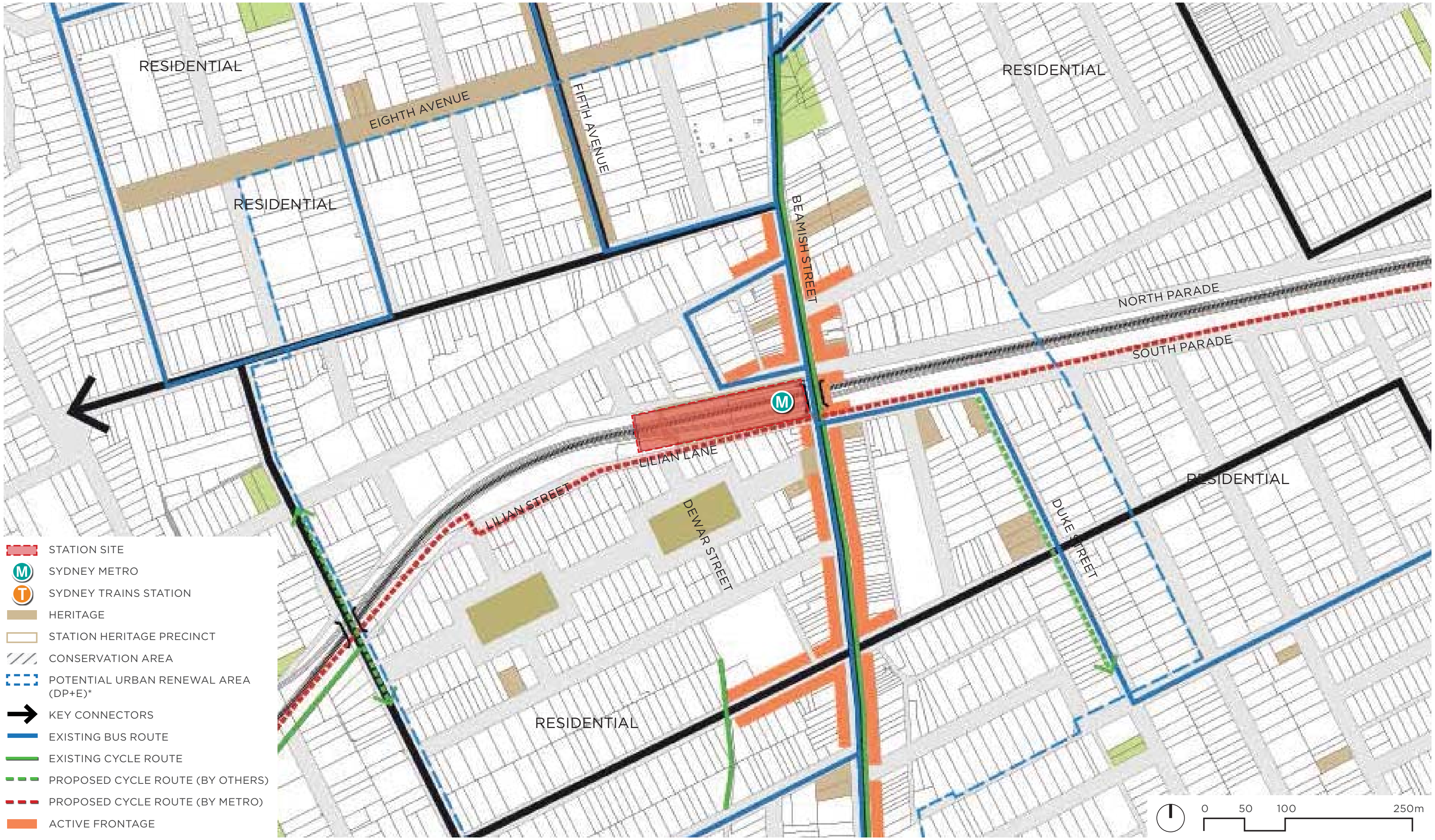
Campsie is the largest commercial centre in the former City of Canterbury local government area and is the civic and administrative hub for the surrounding area. The centre is split into two main areas by the railway line. The primary commercial strip extends along a distance of approximately 900m.

The centre generally has a traditional, fine grain built form with 1–2 storey high street buildings. Although buildings within Beamish Street are of varied architectural styling, it has a consistent form created by building height and street width proportions. Larger buildings include the council chambers within the northern section of the core and the Campsie Centre shopping centre in the southern section.

There are also a number of more recent 4–6 storey shop top housing developments. These are generally located on the eastern and western perimeter of the Beamish Street commercial strip.

The residential areas surrounding the commercial core consist of a mix of two to three storey walk up residential flat buildings and single detached houses on relatively large lots dating from around the mid 20th Century.

Campsie Food Festival
Source: Weekend Notes



Campsie Station Local Context Plan

* Source: Sydenham to Bankstown Urban Renewal Corridor Strategy 2015

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Campsie Station Urban Design Strategies

Station and public space as catalyst

- Contribute to the urban renewal of Campsie town centre.
- Improved public domain on Beamish Street, Lilian Lane and North Parade to generate wider precinct improvements.
- Retention of station address on Beamish Street will keep the station as the central focus of the precinct.

High Street character

- New station will reinforce Beamish Street as the central spine of the town centre.
- New retail buildings on the station concourse and the station canopy will maintain the consistent street wall of Beamish Street across the alignment. 1
- New retail buildings on the eastern side of the Beamish Street will reinforce retail street wall.

Public domain and pedestrian amenity

- Generous 8 metre setback to create station forecourt and ease pedestrian congestion in front of station.
- New station entry and footpath upgrade on North Parade. 2
- Landscaped shared zone on southern approach to station on a widened Lilian Lane. 3
- Widened footpath on eastern side of Beamish Street.

Accessible interchange

- Greater concentration of interchange provision adjacent to station, specifically:
  - Maintenance of existing bus stops and services.
  - New taxi and kiss and ride bays.
  - Secure and sheltered bicycle parking.
  - Active transport link along Lilian Street and Lilian Lane. 4

2.7 Belmore

Centre type: Local Centre

Primary Function: Origin

Catchment: Residential and retail

Local Government Area: City of Canterbury Bankstown

Station & Platform Type: Surface in cutting, island platform

Context
Belmore Station is located on Burwood Road in Belmore, approximately 14km south-west of the Sydney CBD in the City of Canterbury-Bankstown. The existing station on Burwood Road lies in the centre of the town centre strip shopping centre. The proposed Metro station at Belmore is located to the east of the existing station entry with an entry plaza on the southern side of the alignment and a shared interchange zone on Tobruk Avenue.

The suburb of Belmore is bounded by Belfield to the north, Campsie to the east, Kingsgrove to the south and Lakemba to west. Belmore is characterised by low scale built form, generally single or two-storey detached housing and apartment blocks. Although there are three discrete areas of land with higher density zoning in Belmore, the prevailing character of the suburb is established by its many detached bungalows on relatively large lots.

Key design drivers:
- Retention of state heritage listed platform building made possible through relocation of station entry and concourse to the east.
- Creation of an interchange zone on Tobruk Avenue adjacent to station plaza with associated changes to traffic flow on Tobruk Avenue and signalisation of the Tobruk/Burwood/Bridge intersection.
- A large public plaza on Tobruk Avenue to connect the town centre, the station and Belmore Park/Sports Ground.

Belmore Station
Source: COX/HASSELL

Belmore town centre, Burwood Road
Source: COX/HASSELL

Existing buildings, Burwood Road
Source: COX/HASSELL

Burwood Road station entry
Source: COX/HASSELL

Landscape and Urban Character

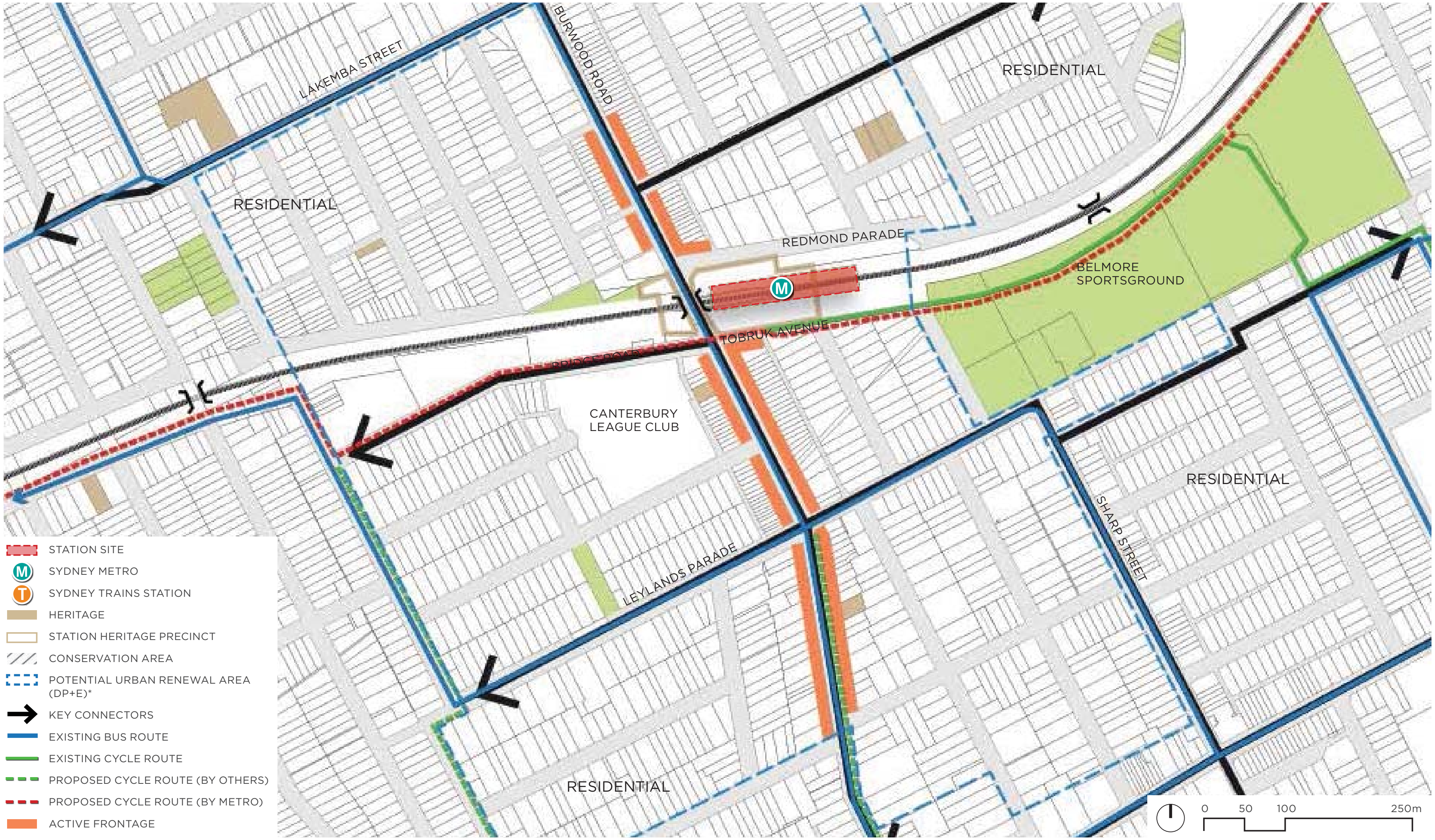
The Canterbury League Club building on Bridge Road is the most significant built form within the locality. In addition, the nearby Belmore Sports Ground and the landscaped open space and pedestrian walkway from Burwood Road are also key land use features of the precinct.

The centre generally has a traditional, fine grain/ human scale built form with 1–2 storey high street buildings.

The surrounding precinct has three discrete areas of higher density residential development. Compared to the adjoining precincts of Campsie and Lakemba, the precinct is relatively small and has a smaller area of strata titled buildings. The outer residential areas of the precinct are largely occupied by single detached houses on relatively large blocks dating from around the mid-20th century.

Belmore retains much of its early twentieth-century Federation and interwar California Bungalow housing stock.

Belmore Sports Ground, home to Canterbury Bankstown Bulldogs and Sydney Olympic FC
Source: NBA Live Score Now



Belmore Station Local Context Plan

* Source: Sydenham to Bankstown Urban Renewal Corridor Strategy 2015

Belmore Station Urban Design Strategies

A Public Plaza Connecting Park and High Street

- A landscaped urban plaza will connect the station, the Burwood Road village and the linear parkland of the Belmore Sports Ground. 1
- A small, northern entry plaza on Redman Parade which will include retail development, secure bicycle parking, public seating, artwork and landscaping.

A Green Connected Corridor

- A generous station plaza and shared zone on Tobruk Avenue. 2
- Tobruk Avenue/Bridge Road/Burwood Road will become a signalised intersection, improving vehicle, pedestrian and cycling connectivity from east to west.
- The crossing and shared zone will link the proposed on-road cycle route on Bridge Road to the shared path through Belmore Sports Ground.

Belmore Town Centre Urban Renewal

- Metro at Belmore will contribute to the renewal of the town centre. Zoning proposals outlined in the Department of Planning and Environment's Sydenham to Bankstown Draft Urban Renewal Corridor Strategy (2015) allow for 3-5 storey shop-top housing along Burwood Road and a mixture of medium and high density development within 400 metres of the station.
- Future development on the Redman Parade site could include a northern station entry.

Accessible Interchange

- The Tobruk Avenue shared zone will consolidate taxi and kiss and ride bays immediately adjacent to the station plaza with additional provision on Redman Parade. 3
- Secure bicycle parking will be located in the plaza.
- Bus stops on Burwood Road will remain within 50 metres walking distance of the station plaza.

2.8 Lakemba

Centre type: Local Centre

Primary Function: Origin

Catchment: Residential

Local Government Area: City of Canterbury Bankstown

Station & Platform Type: Surface in cutting, island platform

Context
Lakemba is located 15km south-west of Sydney CBD and is located in the City of Canterbury-Bankstown. The suburb is bounded by Greenacre to the north, Belmore to the east, Roselands to the south and Wiley Park to the west.

The main retail/commercial strip runs north-south along Haldon Street with extensions to it on Railway Parade and The Boulevarde, adjacent to the station. Haldon Street is an attractive and dynamic retail strip, and a slow traffic environment, conducive to pedestrian and social activity. The existing station plazas are well used public spaces.

The wider precinct takes in a number of community, religious, cultural and educational sites, from the Lakemba Library and Lakemba Club on The Boulevarde, the Lakemba Mosque on Wangee Road, the Musallah (outdoor Mosque) on Railway Parade and Haldon Street, to a range of private and public schools (Hampden Park Public School, Holy Spirit College, Risallah College and St Therese's Public School.

Key design drivers:
- Retention of station entries in existing well-used plazas, on The Boulevarde and Railway Parade.
- Extension and modification of plazas to allow accessible interchange provision and increased public amenity.
- Protection and retention of plaza memorial and mosaic.

Railway Parade station entry
Source: COX/HASSELL

The Boulevarde, Lakemba
Source: COX/HASSELL

Railway Parade Reserve with multicultural mosaic and Mediterranean plantings.
Source: COX/HASSELL

The Boulevarde plaza, WWI Memorial
Source: COX/HASSELL

Landscape and Urban Character

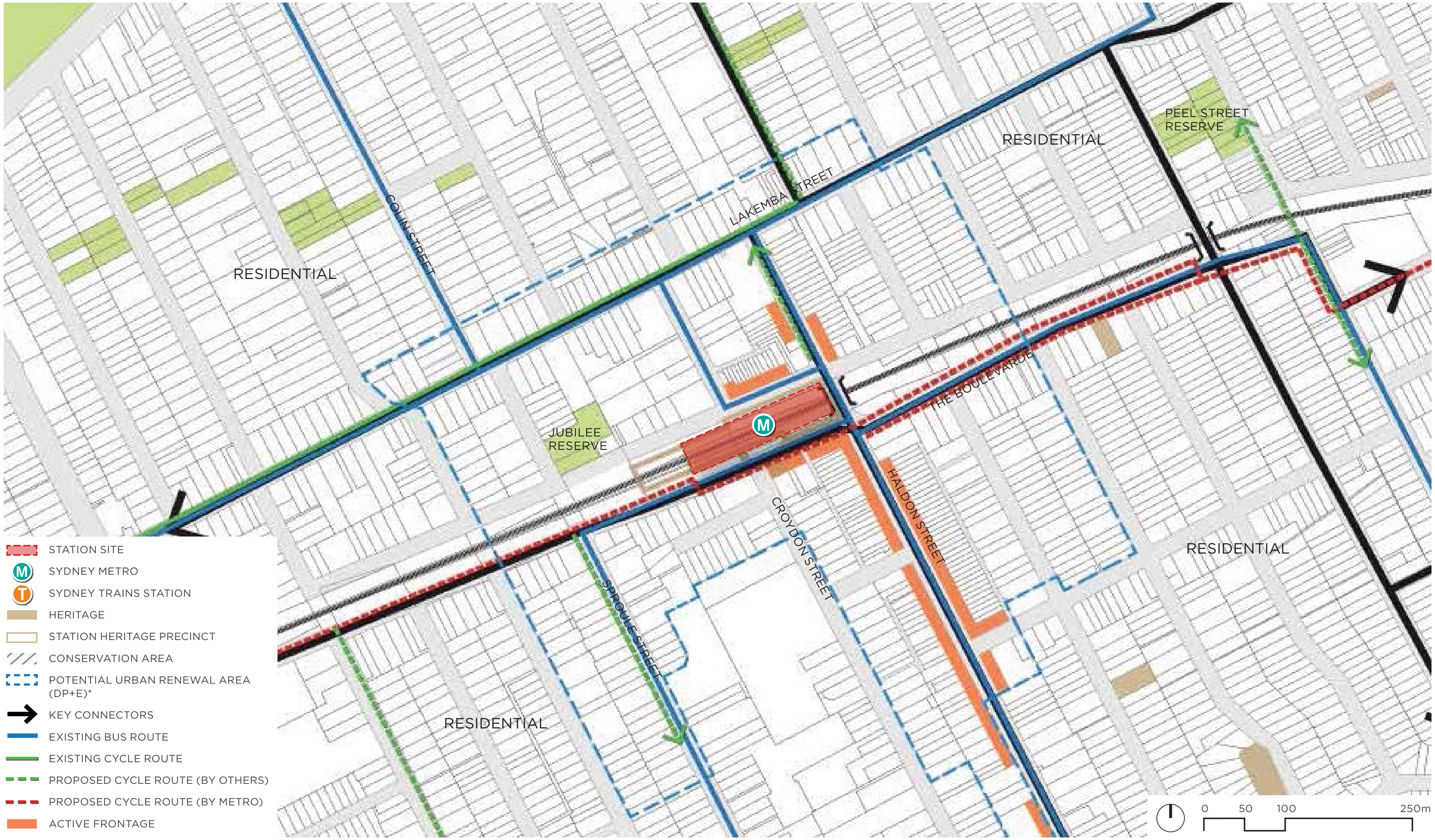
Lakemba town centre comprises a retail/commercial strip running north-south along Haldon Street. The centre has a traditional, fine grain built form with 1–2 storey high street buildings. Although buildings within Haldon Street are of varied architectural styling, it has a consistent form created by building height and street width proportions. Together with its low vehicular speed and narrow carriageway, Haldon Street provides a comfortable and attractive public domain for pedestrians.

The town centre is surrounded by an area of medium density housing. Strata titled apartment buildings are generally concentrated within the western portion of the high density residential area.

The outer areas of the precinct are largely occupied by single detached houses on relatively large lots dating from around the mid 20th century, including some weatherboard housing stock.

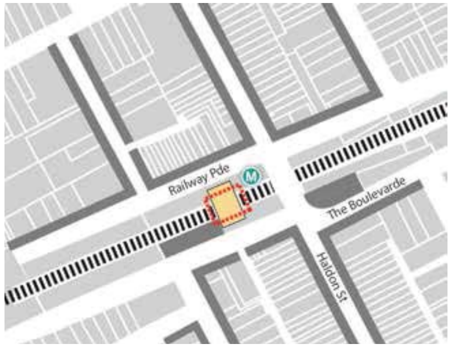
Lakemba Mosque
Source: Skyscraper City

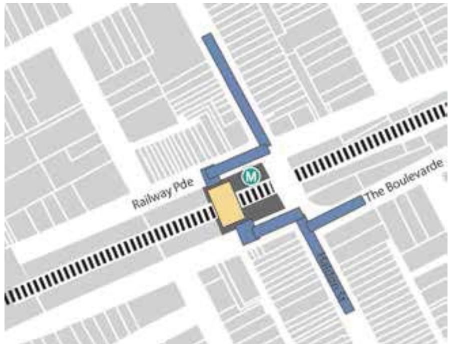
Haldon Street Festival
Source: Haldon Street Festival

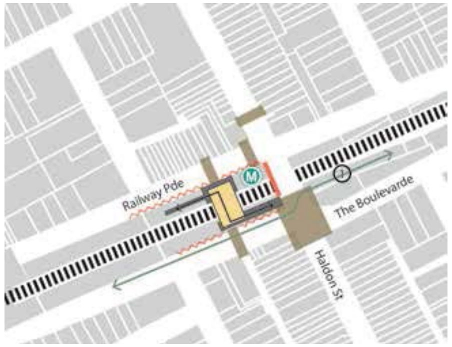


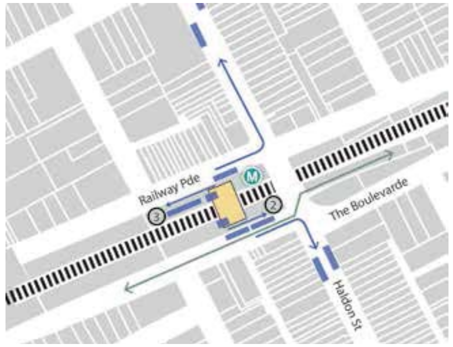
Lakemba Station Local Context Plan

* Source: Sydenham to Bankstown Urban Renewal Corridor Strategy 2015









Lakemba Station Urban Design Strategies

Station and Public Space as Catalyst

- The station and its plazas will contribute to the wider urban renewal of the precinct.
- The existing low rise retail site south of the station is a significant development and activation opportunity.

Public Domain

- The extension and upgrade of station plazas has the potential to generate wider public domain improvements in the town centre.
- The war memorial and local mosaic will be maintained as features of the new plazas.
- Tree planting in the plazas can build on the Mediterranean theme currently apparent in the northern plaza.

Connectivity

- Redevelopment of the southern plaza and an extension west of the northern plaza will allow accessible connections to, respectively, taxi bays and Haldon Street and Railway Parade kiss and ride bays.
- The proposed active transport corridor will provide an on-road cycle route adjacent to Lakemba Station. 1
- Separated paths are proposed in the corridor west of the station and a cycle path in the corridor to the east.

Accessible Interchange

- Re-grading of the southern plaza will create an accessible connection to taxi bays and to Haldon Street bus stops. 2
- A kiss and ride zone on Railway Parade with allow for an accessible path to station. 3
- Secure and sheltered bicycle parking.

2.9 Wiley Park

Centre type: Local Centre

Primary Function: Origin

Catchment: Residential

Local Government Area: City of Canterbury Bankstown

Station & Platform Type: Surface in cutting, side platform

Context
Wiley Park is located 17km south-west of Sydney CBD in the City of Canterbury-Bankstown. The suburb is bounded by Greenacre to the north, Lakemba to the east, Roselands to the south and Punchbowl to the west.

The station precinct is dominated and divided by King Georges Road, a busy arterial road with extended clearway hours. There is a small retail centre adjacent to the station on King Georges Road which extends to Lakemba Street.

Three public schools lie immediately south of the station - Wiley Park Girls High, Wiley Park Public School and Lakemba Public School - but otherwise the precinct is predominantly residential. Medium density apartment buildings, of generally 3 storeys, occur just north and east of the station. Remaining areas are typically occupied by single detached houses.

Key design drivers:
- Maintain traditional entry on King Georges Road but with additional openings to The Boulevarde and the northern side laneway for a more permeable station concourse and public domain.
- Wider setback from the main road and landscaped approaches from the west to improve the pedestrian environment.
- New retail kiosk on enlarged station concourse.

Existing Wiley Park station entry
Source: COX/HASSELL


King Georges Road
Source: COX/HASSELL


Wiley Park Station platforms
Source: COX/HASSELL


Cao Dai Vietnamese Temple, King Georges Road, Wiley Park
Source: COX/HASSELL

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Landscape and Urban Character
Wiley Park comprises a small local centre and has a limited range of retail and takeaway food and drink premises, focused on King Georges Road and Lakemba Street.

The centre is largely occupied by convenience and fast food type uses, together with the Wiley Park Hotel. Built form is generally 1–2 storey shop-top housing buildings with the exception of two larger and more recent mixed-use buildings.

The precinct is characterised by medium-density residential flat buildings to the north and east of the commercial core. This area generally consists of older, small scale (3 storey) buildings occupying narrow sites with a high proportion of strata-titled properties. Outside the core, residential areas are largely occupied by single detached houses on relatively large blocks dating from around the mid-20th century.

Wiley Park Amphitheatre
Source: City of Canterbury Bankstown

Wiley Park Station Local Context Plan

* Source: Sydenham to Bankstown Urban Renewal Corridor Strategy 2015

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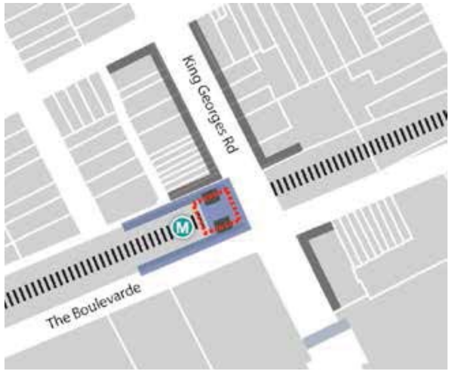
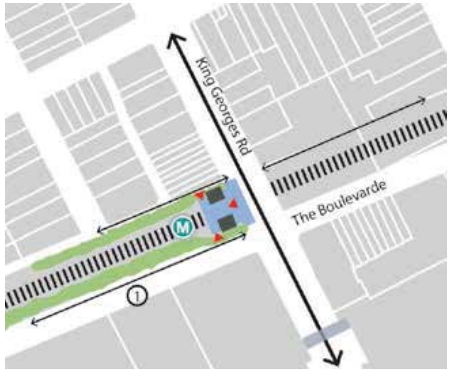




Wiley Park Station Urban Design Strategies

New Metro Station as Local Catalyst

- The new station and its associated plazas will introduce a new urban standard to this currently run down urban setting.

Public Domain

- Attractive station forecourt.
- More generous setback of station from King Georges Road.

Pedestrian Environment

- Landscaped pedestrian approaches to the station.
- Station design creates a more permeable entry arrangement, with entry from the north, east and south.
- Extended shared path on the southern side of the station as part of a future active transport corridor. 1

Accessible Interchange

- At-grade accessible connection to interchange zone on The Boulevarde.
- Secure and sheltered bicycle parking.
- Shared path as part of future active transport corridor on southern station approach. 2

2.10 Punchbowl

Centre type: Local Centre

Primary Function: Origin

Catchment: Residential and education

Local Government Area: City of Canterbury Bankstown

Station & Platform Type: Surface, side platform

Context
Punchbowl is located 17km south-west of Sydney CBD and is within the City of Canterbury-Bankstown. The suburb is bounded by Greenacre to the north, Wiley Park to the east, Riverwood to the south and Bankstown/Mt Lewis to the west.

The immediate station precinct is a mix of small retail and commercial premises, recent multi-story apartment blocks, shop-top housing and a range of community, educational and religious institutions. The wider area is largely 2-3 storey walk up apartment blocks and detached housing. The main and most lively retail street is The Boulevarde where the southern station entry is found. By contrast, pedestrians and the businesses on Punchbowl Road suffer from a more hostile traffic environment. Punchbowl Road divides the northern part of the centre around Breust Place from the southern area centred on The Boulevarde. A narrow pedestrian underpass below Punchbowl Road connects Brueust Place back to Warren Reserve and the station. The northern station entry lies in Warren Reserve.

Key design drivers:
- New station entry locations allow for more generous public spaces north and south of the station.
- Relocation of the southern entry will enable a better relationship between the new station and the emerging mixed use, revitalised main street activity along The Boulevarde.
- Creation of the northern plaza and associated paths and landscaping will result in improved circulation and amenity in Warren Reserve.
- An accessible ramp to Urunga Parade and a pedestrian crossing on Punchbowl Road will add accessible, safe connections to the interchange and across the north of the precinct.
- Reconfiguration of the rail tracks provides the opportunity for a replacement pedestrian/cycle under Punchbowl Road.

Punchbowl Station platform
Source: COX/HASSELL

Entry plaza on The Boulevarde
Source: COX/HASSELL

Punchbowl town centre, historic signage
Source: COX/HASSELL

Rest Park (Warren Reserve) approach to northern entry from Punchbowl Road
Source: COX/HASSELL

Landscape and Urban Character

The Punchbowl town centre is spread between Punchbowl Road and The Boulevarde and includes a range of retail, community and residential land use. It extends from the station approximately 200m to the east, south-west and north east in a semi-radial fashion. The rail corridor, coupled with Punchbowl Road, divides the town centre.

In recent times, the commercial precinct has extended further east, with the development of a large multi-building, mixed-use development that includes a supermarket and several minor retail tenancies, with residential apartments above.

Similar shop-top housing, generally 4–5 storeys in height, has also arisen on Punchbowl Road.

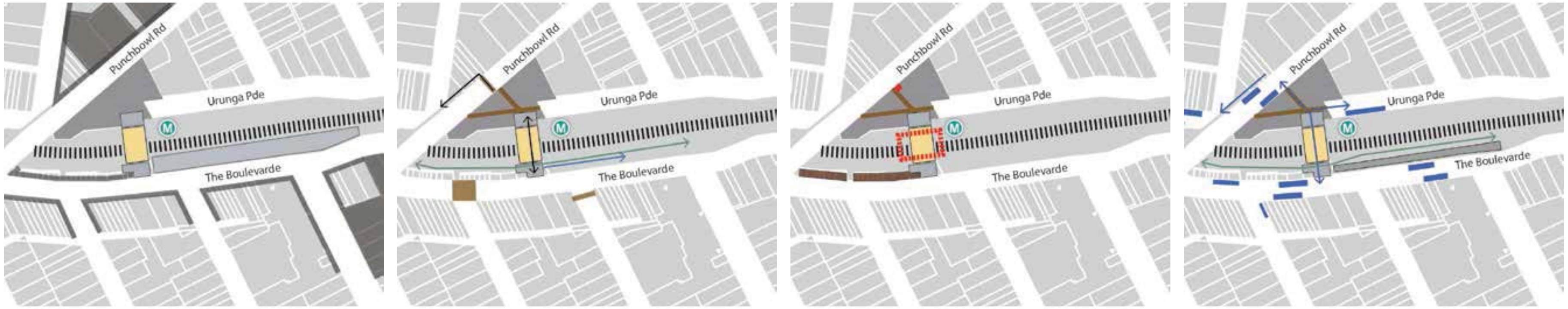
The centre has a finer grain built form, with 1–2 storey High Street buildings. Although building form and architectural expression is varied, the centre is reasonably consistent in terms of building height and street width proportions. The public domain has been upgraded in recent years and is generally a comfortable and attractive place for pedestrians.

The core is adjoined by a large area of higher density zoned residential land to the south. This largely contains existing detached houses and 3 storey walk up residential flats. Land located beyond the Punchbowl Road commercial strip, on the north-western side of the precinct, is generally restricted to low density residential uses.

Punchbowl Community Centre
Source: GroupN

Punchbowl Station Local Context Plan

* Source: Sydenham to Bankstown Urban Renewal Corridor Strategy 2015



Punchbowl Station Urban Design Strategies

Station and public space as catalyst

- Recent development pattern evident on The Boulevarde and Punchbowl Road likely to extend throughout the centre with the advent of Metro station.
- Large site south of the station suited to mixed use or residential development.
- New station plaza likely to promote new retail and commercial activity.

Public domain, access and circulation

- The new station plaza on The Boulevarde will provide a generous public space for the centre.
- Pedestrian and cycle paths will connect to the station plaza and the adjacent car park.
- A new signalised crossing on Punchbowl Road will provide safe connections to Breust Place and to the north of the precinct.

Station address and legibility

- Station entry plazas will create clear view corridors to the station from the precinct.
- The Metro entrance will be highly visible in the centre and specifically from the Punchbowl Road bridge.

Interchange

- The eastbound bus stop on The Boulevarde and is proposed to be moved closer to the new station plaza.
- A new crossing on Punchbowl Road to eastbound bus stop and to school bus stops on Breust Place.
- New taxi and kiss and ride bays are proposed and taxi bays on Arthur Street will remain.
- Dedicated kiss and ride and accessible parking bays are proposed on Urunga Parade.
- Generous secure and sheltered bicycle parking.

2.11 Bankstown

Centre type: District Centre

Primary Function: Origin, Destination and Interchange

Catchment: Employment, retail, civic, interchange

Local Government Area: City of Canterbury Bankstown

Station & Platform Type: Surface, island platform

Context

Bankstown is located 20km south-west of Sydney CBD and is located in the City of Canterbury-Bankstown Local Government Area. The suburb is bounded by Potts Hill to the north, Punchbowl to the east, Padstow to the south and Condell Park to the west.

Bankstown is a major strategic centre in southwest Sydney with strong employment, civic, retail functions. It also is a significant centre of interchange between bus and train services. The building stock and urban form is varied, from larger twentieth century commercial buildings, a range of public buildings and spaces, shops and residential buildings of traditional scale and more recent multi-storey apartment buildings.

The Bankstown CBD is centred on the Bankstown station and exhibits a vibrant street character, especially on smaller commercial streets such as Bankstown City Plaza and Chapel Road. Large retail centres like Bankstown Central and their attendant surface and/or rooftop car parking also typify the centre. A civic precinct north of the station features striking new architectural buildings including the library overlooking a major town centre park. Other key civic buildings include a performing arts centre/theatre adjacent to the library. The rail corridor and the South Terrace bus interchange and its associated restricted traffic pattern profoundly divide the centre.

Key design drivers:

- New station concourse to provide direct, fully accessible connection to Metro platforms and secondary access to Sydney Trains' platforms.
- New concourse and extensions to existing plazas to provide an unpaid cross-corridor connection in central Bankstown.
- Southern plaza extension to provide a forecourt to heritage listed former Parcels Building.

Bankstown Station platform
Source: COX/HASSELL

South Terrace bus interchange
Source: COX/HASSELL

Recent apartment development along South Terrace
Source: COX/HASSELL

Bankstown City Plaza
Source: COX/HASSELL

Landscape and Urban Character

Bankstown offers extensive retail, community and civic services within a CBD precinct focused on the northern and southern sides of the Bankstown Station.

Building stock varies considerably in age, condition and architectural presentation. Key building typologies include older style attached shop fronts with office space or residential development above, larger commercial office buildings from the late 20th century and newer civic buildings around Paul Keating Park.

Other key sites within the CBD include the Bankstown Central Shopping Centre, Bankstown Sports Club and Bankstown RSL Club.

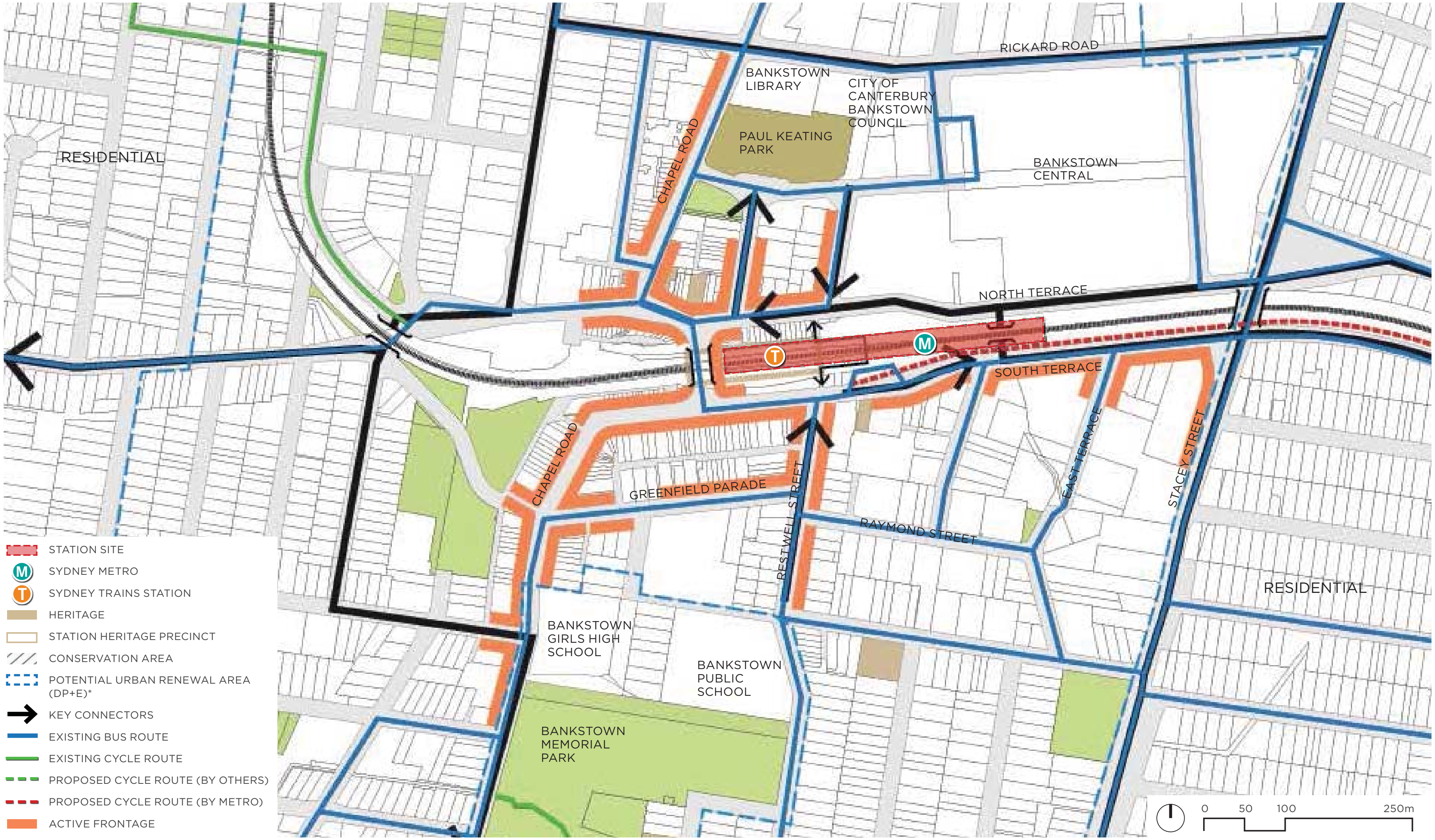
Residential buildings within the north-east, north-west and south eastern precincts surrounding the CBD core also vary significantly in age and style from 3 storey walk up flats to more modern strata title, multi-storey residential flat buildings over basement car parking.

The majority of the building stock has been constructed within the later part of the 20th century with limited newer stock present near to the railway line. These buildings are often interspersed with a number of single storey dwellings which are yet to be redeveloped, particularly within the northern precinct.

Beyond this area, there is generally lower density housing with a number of more modern villa and townhouse style developments present.

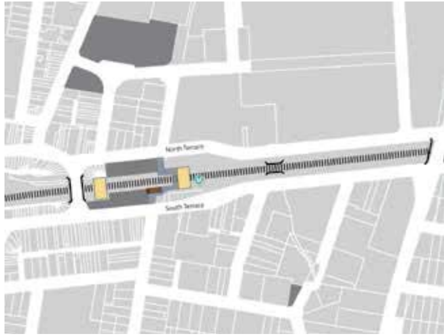
Sydney Eid Festival, Paul Keating Park
Source: Daily Telegraph

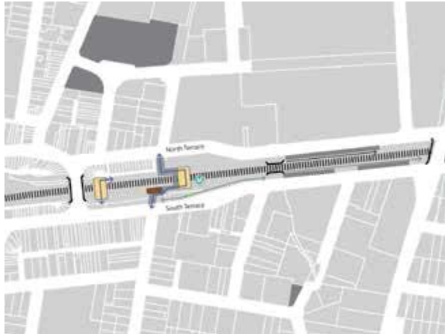
Youth Week 2015, Paul Keating Park
Source: Chirstopher Woe Photography

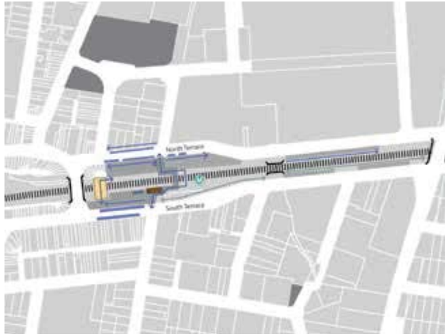


Bankstown Station Local Context Plan

* Source: Sydenham to Bankstown Urban Renewal Corridor Strategy 2015







Bankstown Station Urban Design Strategies

Station and public space as catalyst

- New Metro station and high frequency service will reinforce Bankstown's strategic role in Sydney's southwest.
- The station is likely to stimulate urban renewal and greater housing density in the centre, building on recent development on South Terrace, and supporting mooted regeneration of retail and commercial sites north of the station.

Public domain

- Existing station plazas will be extended eastwards to serve Metro entries, providing additional public amenities.
- Metro will introduce an unpaid concourse across the corridor, enabling additional mid-block pedestrian access.
- Southern plaza extension will provide an improved setting for the heritage listed Parcels Building.

Connectivity and access

- Existing unpaid Sydney Trains concourse will remain.
- New unpaid cross-corridor connection aligned to Restwell Street/The Appian way.
- New access paths servicing commuter parking east of the station.
- Southern access path doubling as active transport link shared path.

Accessible interchange

- Bus interchange will remain on South Terrace.
- Extended taxi and kiss & ride zones on North Terrace.
- Generous secure and sheltered bicycle parking in the station plaza.
- Accessible parking bays on North Terrace.
- Active transport link on southern side of the alignment.

3

Function & Experience

About this Section

This section provides guidelines for the spatial and functional design of the urban and public domain in each station precinct, as well as the urban form of associated project development. The guidelines are articulated according to a number of core design strategies that guide the planning and design of Metro stations and their precincts. The strategies are grouped under the following family headings:

- An Easy Customer Experience
- Identity
- Connectivity

More detailed design guidelines and key requirements for each of these strategies will be included in the scope and performance documents during the procurement stage.

The customer is at the centre of design.
Source: TfNSW

3.1 An Easy Customer Experience

An easy customer experience is central to all aspects of the Sydney Metro design. A high quality customer transport product across the whole 'door-to-door' customer journey is critical to the customer experience. Sydney Metro will be a fast, safe, reliable, easy service for all customers.

Sydney Metro will cater to all customers including daily commuters, people with disabilities, families and infrequent users.

The key public transport customer service design principles which underpin customer focused design are provided below.

Public transport customer service design principles

Balanced: Functional performance is balanced with customer service to achieve high levels of customer satisfaction.

Efficient, assisted service: A self-service system that is designed for easy, intuitive use. Where assistance may be required, support is available and easy to get.

Universally accessible: Meet the needs of all members of the community, accommodate the distinct needs of key customer segments.

Flexible: Able to adapt to a range of typical usage patterns and services while delivering a consistent level of service outcomes.

Legible and consistent: Reflect a service style and tone that is easily understood and consistent with the experience of an integrated transport system.

Responsive: A service system open to feedback from customers, that adjusts over time as needs and preferences change, and continuously improves.

This part of the document provides guidelines for the following areas of the customer experience:

- Customer Centred Design
- Customer Circulation
- Wayfinding and Legibility
- Comfort and Amenity
- Customer Safety
- Accessibility

Provide an easy experience for a diverse range of customers.
Source: TfNSW

3.1.1 Customer Centred Design

Relevant Design Objectives	
1	Ensuring an easy customer experience

Principle

Customer Centred Design (CCD) is the process that brings the 'customer to the centre of everything we do'.

Guidelines

Analysis of contextual data to understand the customer's environment.

Understand the needs and behaviours of customers for whom we are designing.

Uncover the root cause of customer pain points and build empathy through customer stories.

Articulate the problems to be solved for our customer segments.

Generate ideas and evaluate to ensure customer/problem fit.

Development of ideas to prototypes (both low and high fidelity).

Validation of product/ solution fit with customers.

3.1.2 Customer Circulation

Relevant Design Objectives

1	Ensuring an easy customer experience

Principle

Provide adequate space to meet customer demands, including during peak periods and long-term patronage demands. Provide customer circulation that is comfortable, enabling an easy customer experience.

Guidelines

- Each part supports a different range of functions that must be addressed on station opening and in future scenarios.
- The movement capacity, configuration and spatial sequences of each of the Sydney Metro stations is to respond to patronage requirements as defined by a Level of Service (LOS) appropriate to the location and context.
- Pedestrian paths, crossings and spaces adjacent to Sydney Metro stations are to have sufficient capacity to meet potential demand with particular consideration of key decision points (gatelines, entrances, exits, customer queue zones) and information points. Where constrained, this may be met by extending the public domain into the station forecourt.
- The customer circulation paths within the station are to optimise timeliness for customers moving between concourse, platform, and station entries.
- Circulation paths are to be designed for convenience of connections into the station and from surrounding areas and other transport modes. These should reflect pedestrian desire lines as much as possible to enhance the convenience of circulation routes.
- Provide natural light over primary customer circulation zones where possible.
- To deliver ease, safety and efficiency, stations must cater for and avoid friction between habitual-use customers and unfamiliar customers. Information and services for each type of customer should coexist without friction.
- Ancillary development and activities (retail, commercial or residential development, services areas and advertising structures) within Sydney Metro station sites are not to compromise efficient transport operations.
- All areas are to provide sufficient space for emergency access and movements in accordance with relevant design standards and legislation.

South Morang Rail Extension, Vic. Clear sight lines and circulation paths through station entry.
Source: COX, Copyright: Dianna Snape

3.1.3 Wayfinding and Legibility

Relevant Design Objectives	
1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system

Principle

Provide intuitive, clear and consistent wayfinding as well as legible, intuitive spaces to enhance customer journeys through efficient navigation and interchange. Wayfinding is to create a seamless and intuitive customer journey from origin to final destination to support an easy customer experience.

Guidelines

- Planning for wayfinding and legibility will support all customers to travel independently and easily on Sydney Metro. This is done by:
  - Anticipating the needs of customers
  - Providing the accurate information at the right time
  - Planning and creating predictable and intuitive environments
  - Applying consistent system of signs and information.
- Spaces are to be visually simple and intuitive to negotiate, to contribute to an easy customer experience. This is done by:
  - Providing visibility between station levels where possible
  - Using intuitive design to minimise wayfinding choices and the need for signage
  - Providing safe, legible, efficient, convenient, obstruction free, level, direct and attractive routes for customer access
- Wayfinding must be easily understood by all customers and reduce the need for customers to ask staff for directions and information.

Note - further guidelines on Information and Signage are set out in Section 4.4.1

Legible spaces at North Sydney Station
Source: COX

3.1.4 Comfort and Amenity

Relevant Design Objectives	
1	Ensuring an easy customer experience

Principle

Provide a comfortable customer environment that provides sufficient personal space and amenity and is well lit with effective and appropriate microclimate amenity for all users.

Guidelines

- Station entry orientation and design are to minimise adverse micro climate effects including wind tunnel impacts.
- Customer weather protection outside Sydney Metro stations is to be provided to ensure good levels of customer comfort are maintained and to provide useable spaces at ground level.
- A range of customer facilities and amenities is to be provided to grow patronage by making public transport a more attractive choice.
- A high level of amenity and security in customer waiting areas is to be provided to positively influence patronage and perceptions of the public transport system.
- Waiting areas, pedestrian walkways and cycle ways are to have adequate shade and day and night time lighting, while minimising energy consumption, providing an appropriate balance between sun access in winter and shade in summer.
- Minimise urban heat island effect through light coloured finishes, roofs and pavements, green walls, roofs, plantings and shade trees.
- Furniture and materials selected are to be appropriate to the local climatic environments.

West End Ferry Terminal, QLD. Shaded seating areas provide comfortable places for customers to wait with high visibility to the surrounding area.
Source: COX, Copyright: Christopher Frederick Jones

3.1.5 Customer Safety

Relevant Design Objectives

1	Ensuring an easy customer experience

Principle

Ensure stations and precincts provide a safe and secure environment for customers and also contribute to the overall public safety of urban places throughout the day and night.

Guidelines

General

- Design for safety is to be optimised through the application of relevant Crime Prevention through Environmental Design (CPTED) principles and guidelines.
- Integrated CCTV systems must be provided at entry and exits, stairways, ramps, bridges, lifts, ticket office and vending machines, emergency help points, public telephones, waiting and seating areas in accordance with Australian Standards and Sydney Metro requirements.
- Vandal-resistant fittings and fixtures are to be used throughout.

Public Domain

- An initial CPTED review of station precincts is to assess activity generators, edge effects, movement predictors, conflicting user groups, crime hotspots, the 'displacement phenomenon' and building elements
- All public domain areas are to be planned with guidance from CPTED experts, adopt a risk prevention design approach and eliminate entrapment and concealed space opportunities.

Stations

- The station design is to incorporate CPTED strategies:
  - Eliminating hidden spaces, recesses or voids that could provide a person with the ability to conceal themself or others from general view.
  - Secured stations out of operating hours and during emergencies.
  - Ticket Vending Machines positioned to allow surveillance.
  - Minimising inadvertent or intentional access to hazardous or unauthorised areas of the station.
  - Physical barriers to minimise the risk of trespass or self-harm by station users.
  - Protective screening to elevated walkways and concourse areas particularly where persons traverse above or immediately adjacent to the rail corridor.
  - Glazed lift car and lift shaft enclosures to maximise visibility and safety.
- Station designs are to support visible staff presence as close as possible to customer movement and decision making zones to enhance customer safety.
- The stations are to be designed to minimise obstructions and projections, providing clear routes for customers.
- Station designs are to eliminate crush zones and provide equipment at safe and accessible locations.

Help Points

- Help points should be easily identifiable, accessible components integrated into station cladding systems.
- Help points are to be easily differentiated from customer information points.
- Help point enclosures should be integrated with the surrounding wall or equipment cabinet.

Vandal-resistant fittings and levels of visibility between concourse and platform at Cheltenham Station
Source: COX

3.1.6 Accessibility

Relevant Design Objectives	
1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system

Principle

Ensure the stations and associated spaces are safe, efficient, universally accessible, legible and easy for customers and pedestrians.

Guidelines

- Stations and precincts are to be easy, safe and accessible for all to use including the elderly, customers with disabilities, young children and those with prams and luggage.
- As far as possible, pedestrian pathways are to be obstacle and step free to maximise access for all customers. Where the use of stairs cannot be avoided, then they must be easy and safe to use.
- Where obstacles to universal access are unavoidable, clearly legible alternative routes must be provided as close as possible to the main travel path.
- Where stairs are required, clearly legible, alternative accessible circulation routes are to be provided. These alternatives are to be as close as possible and not isolated from the primary circulation route.
- Where lifts are provided as an alternative to stair access they are not to result in a longer journey than the primary circulation route or compromise the safety of customers who need to use them.
- Ramps may provide opportunities for universal access; however, where possible, seek alternative means of effecting level changes, for example, by altering the path of travel.
- All facilities, furniture and fixings must be designed to be accessible to all customers. Accessible and ambulant toilets must be provided.
- Cluster accessible features and facilities as close as possible to each other to avoid lengthy journeys between.
- Priority seats and adequate space should be provided in waiting areas and around groups of seating to accommodate the elderly and customers with disabilities and prams.
- Information must be provided throughout the customer journey that considers user impairment, culture and language.
- Equivalent service and safety information must be provided for customers with disabilities in their preferred accessible format.
- Provide obvious help points for staff assistance where needed.
- All Metro service elements must comply with the Disability Discrimination Act 1992 and associated Public Transport and Premise Standards.

Universal access must be provided to all stations and precinct facilities.
Source: San Francisco Municipal Transportation Agency

Universal access must cater to customers with a wide range of disabilities.
Source: TfNSW

3.2 Identity

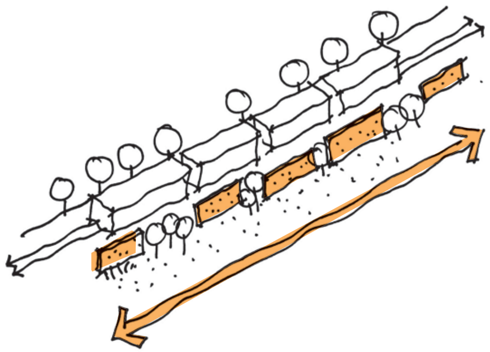
The project is an opportunity to foster an exemplary architectural and urban design experience that connects with the diverse communities along the corridor so that they embrace and identify with the metro, the rail line and the opportunities it creates.

The Sydney Metro line-wide identity relies on consistent themes and design elements across the internal and external areas of the station. It is important that the station entrances engage with their local context to create welcoming landmarks in the urban environment.

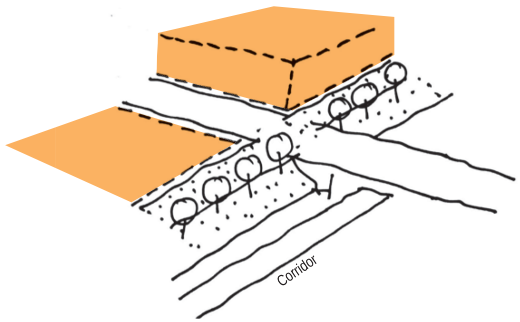
Achieving a 'whole-of-corridor' identity for Sydney Metro is a key design objective. The design strategies in this section contribute to the character, appearance, accessibility and function of the stations and their surrounding precincts. A unified approach can be fostered through adherence to common strategies for buildings and structures, finishes, accessibility and legibility that respond to local contexts while forming part of a 'whole-of-corridor' identity.

This part of the document provides guidelines for the following areas of creating a Sydney Metro identity:

- Network and Station Legibility
- Place Making
- Heritage & Archaeology
- Environment & Sustainability
- Corridor Landscape
- Art
- Lighting



Rediscover



Renew

3.2.1 Network and Station Legibility

Relevant Design Objectives	
1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system
4	Being responsive to distinct contexts and communities

Principle

Create a line-wide identity for the Sydenham to Bankstown project that is recognisably part of the Sydney Metro network while enabling elements of station design to respond to context, character and environment to create locally distinctive sustainable outcomes.

Guidelines

- A network identify has been established for the metro service, including a brand and key system element.
- A line-wide identity is to be established through the architectural language and layout of the station types (open cut / at grade – island platform / side platform).
- The architectural language and elements of the transport infrastructure and stations are to form a line-wide design that reinforces the Sydney Metro identity within the broader transport network.
- The stations are to maintain a coherent identity with consideration of:
  - Network identity
  - Line-wide identity
  - Local identity
  - Interchange with other modes of travel.
- Stations, service facilities, public domain elements, component elements and the rail corridor are all to form part of the identity and project an image which evokes a modern, contemporary and efficient transport system providing an attractive, comfortable, safe and inspiring customer environment, while also responding to the local context and environment.

Architectural elements are to form a line-wide identity.
Source: COX

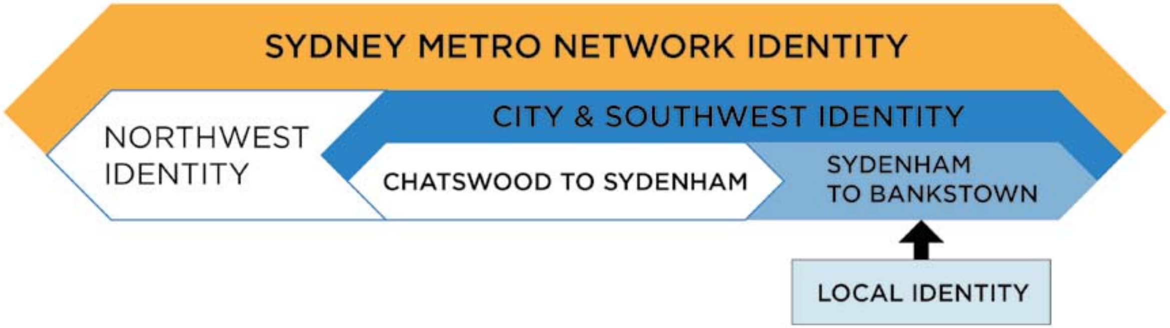


Diagram highlighting the various layers of identity that should be considered in the design.

3.2.2 Place-making

Relevant Design Objectives

1	Ensuring an easy customer experience
3	Being a catalyst for positive change

Principle

Create welcoming, secure and well maintained public domain spaces and station buildings with an attractive 'sense of place' that responds to the distinct contexts and cultures of each station precinct.

Guidelines

- Stations and associated spaces are to promote a welcoming image or identity that reinforces a positive sense of place within the locality, and is a positive catalyst for growth.
- Station plazas are to be designed as an extension of the internal station environment providing shelter, comfort, safety and security for customers, and contributing positively to customer journey experiences. These spaces are to reflect the local public realm context and character.
- Enhance station spaces by introducing a range of uses, services and facilities such as retail, food and beverage, shade trees, landscaping and public art.
- New public spaces are to be designed to allow for spontaneous uses and activities, temporary events, pop ups, retail spaces and the night time economy.
- Create opportunities to facilitate the activation of adjoining areas, and informal gathering paces at station entries.
- Apply a consistent hierarchy of landscape treatments to public spaces, reflecting local character and context, integrate within their settings, and provide attractive space and streetscapes, and improve connectivity.
- Fixtures, including furniture and lighting, are to enrich site context and sense of place and contribute to wayfinding.
- A coordinated lighting approach is to create aesthetic consistency across Sydney Metro by defining station address, public domain areas and attracting customers into station forecourts and plazas.
- A positive precinct image is to be developed around the particular heritage values of a place or by the qualities of the existing urban context.

'Solar Tree' St John's Square, London
Artist: Ross Lovegrove
Source: Ross Lovegrove

3.2.3 Heritage and Archaeology

Relevant Design Objectives	
4	Being responsive to distinct contexts and communities
5	Delivering an enduring and sustainable legacy for Sydney

Principle

Ensure elements and items of heritage significance are appropriately managed and respected. Identify opportunities for heritage conservation to contribute to the celebration of local identity in station design.

Guidelines

- Sydney Metro is to be fully integrated within, and sensitive to, its heritage context. This includes built and natural heritage, European and Aboriginal archaeology and may include places, buildings, works, relics, moveable objects or precincts.
- Where Sydney Metro intervenes in or interfaces with heritage places (such as platform buildings and overhead booking office buildings), design excellence is to be sought to support inventive, interpretive and contemporary responses to the heritage values of that place.
- Where appropriate, the design of the rail corridor and station precincts are to integrate and conserve existing heritage items and mitigate any negative impacts.
- Actively anticipate the research, site investigation, salvage and culturally appropriate safekeeping of Aboriginal heritage uncovered by the Sydney Metro project.
- New work is to be based on an understanding of the heritage significance of heritage items, heritage conservation areas and places and is also to take into consideration:
  - Siting - including urban grain, streetscape rhythm, setbacks, orientation and address of buildings, location of boundary walls, key views, significant natural features and archaeological remains,
  - Scale - including wall and floor to floor heights, modulation and façade rhythms, massing, density, proportions, relationship to ground plane, wall modulation including openings and roof planes,
  - Form – including proportion and number of openings, solid to void ratios, roof form, skyline and relationship between internal and external spaces,
  - Materials and colour – giving consideration to characteristic materials, textures, colours, light and shadow,
  - Details – creating complementary relationships between new and old elements to provide visual interest.
  - Landscape character – including indigenous and endemic planting communities, endangered species, and historical plantings.Where heritage items must be removed or relocated, they must be documented.
- Continuous approach to change.
- Where possible retain visual settings.
- Consider options for adaptation where appropriate.
- Interpretation should respond to the sites cultural significance.
- Consideration is to be given to integrating heritage interpretation including public art.

Newtown Station, Sydney. Heritage interpretation.
Architect: NSW Government Architects Office/Caldis Cook Group.
Source: TfNSW

Edmonston Park Station, Heritage Interpretation.
Source: TfNSW

3.2.4 Environment and Sustainability

Relevant Design Objectives

5	Delivering an enduring and sustainable legacy for Sydney

Principle

Ensure best practice sustainable design solutions are adopted for the public domain, stations and buildings, to minimise environmental impacts and benefit customers and local communities.

Guidelines

- Achieve a high level of performance using sustainable design rating systems.
- Adopt energy efficient and low carbon design solutions that minimise the carbon intensity of the project.
- Incorporate passive design solutions to optimise solar access, introduce daylight, and maximise natural ventilation.
- Harness both direct and indirect daylight to minimise energy consumption in lighting, while creating a light and airy ambience in stations and surface buildings.
- Utilise energy efficient lighting and lighting control systems.
- Ensure resilience to climate change, by incorporating climate change adaptation measures which respond to weather extremes, including flood risk, and temperature increases.
- Provide a positive journey experience in station precincts by protecting users from the potential negative impacts of extreme weather.
- Ensure designs respond to the local microclimate and incorporate opportunities to reduce heat island effects, including (as appropriate) light coloured finishes, roofs and pavements, green walls or roofs, plantings, and shade trees.
- Furniture and materials selection is to be appropriate to local climatic conditions, particularly where exposed to direct sun.
- Include integration of renewable energy sources at stations and in the public domain where feasible.
- Consider water efficiency in design, utilising water from recycled sources where appropriate.
- Opportunities for collection, treatment, storage and reuse of rainwater from station roofs, canopies and other surfaces are to be incorporated within the urban environment.
- Reuse rainwater for public domain irrigation and station toilets where possible.
- Water Sensitive Urban Design (WSUD) initiatives are to include an integrated and site-responsive range of design solutions, influenced by urban design considerations and be adaptable into the future.
- Prioritise reuse of materials, use of recycled materials, and selection of materials from sustainable sources.
- Use durable, climate resilient, long life, healthy, low maintenance materials.
- Minimise materials consumption, and reduce embodied energy and impacts in materials selection.
- Maximise opportunities for beneficial reuse of spoil in landscape features and other uses.
- Provide noise control measures to ensure appropriate and comfortable acoustic conditions for users.
- Minimise waste through efficient design and material selections.
- Consider the use of locally sourced materials wherever practical.

WSUD initiatives integrated at Cheltenham Station.
Source: COX

3.2.5 Landscape

Relevant Design Objectives	
2	Being part of a fully integrated transport system
3	Being a catalyst for positive change
4	Being responsive to distinct contexts and communities
5	Delivering an enduring and sustainable legacy for Sydney

Principle

The landscape design is an important component of a positive, high quality and appealing public domain identity for Sydney Metro stations and the rail corridor. Consistent, well resolved landscape design at each station is required to achieve a clear Sydney Metro standard for the whole southwest alignment.

Guidelines

- Station landscape design should respond to the character of each precinct with planting tailored to suit local soils and microclimate, the development environment, heritage values and social context.
- Landscape design should be appropriate to functional station and related transport operations settings. It must address safety-in-design issues relevant to a transport customer and adjacent road and public realm environment.
- Landscape treatments must be designed to provide appropriate scale and comfort to users throughout the seasons.
- Planting in the corridor should be derived from the previously naturally occurring vegetation communities unless appropriate species in terms of scale or form are not available from these particular plant groupings. In such circumstances, alternative native species suited to local conditions must be used.

Park at Bankstown Station.
Source: TfNSW

Integrate new facilities with corridor and precincts. Interchange car parking facilities at Wyong.
Source: RMS

Existing mature Eucalypt at Belmore Station to be retained in the new station plaza.
Source: Hassell

3.2.6 Art

Relevant Design Objectives

1	Ensuring an easy customer experience
4	Being responsive to distinct contexts and communities

Principle

Ensure public art is integrated within the design of stations and station plazas to aid place making. Enhance local amenity and celebrate local character and enhance the customer experience.

Guidelines

- Public art is to enhance the customer experience, bringing joy to customers and adding value to the operation and success of Sydney Metro by contributing to station identity, beauty, amenity, wayfinding, safety, security, community values and the public domain.
- Public art is to be integrated into the station and building designs to enliven and enrich the public realm and contribute to a sense of place.
- The design and location of art works is to be coordinated within the broader urban context of Southwest stations.
- Consider the re-installation of artworks present in existing buildings or streets to be changed as part of Sydney Metro works.
- Artworks are to contribute to the cultural identity of precincts and neighbourhoods and are to be developed in consultation with the local community and stakeholders.
- Maximise community involvement/representation/ownership in public art.
- Art works must be located to support the safe intermodal function of precincts around Metro stations.
- In station concourse and precinct areas, appropriate integration is required of permanent artworks with station wayfinding, information and other customer amenities.
- Public art is to be integrated but separate from the architecture, budgeted and managed from the architectural scope.

Artwork may also be incorporated into the public realm as part of a local placemaking strategy. FIDO, Fairfield Station, VIC
Artists: Ian Sinclair, Jackie Staude, David Davies and Alistair Knox
Source: Fairfield Village

Artwork may be incorporated into the public realm as part of a building element. Lewisham West Light Rail Stop Platform Shelter. Artwork by Sarah Drury
Source: Courtesy of Marla Guppy and Associates

3.2.7 Lighting

Relevant Design Objectives

1	Ensuring an easy customer experience
4	Being responsive to distinct contexts and communities

Principle

Ensure a coordinated approach to lighting that responds to the local context, addresses CPTED and operational requirements and provides feature lighting representative of the Sydney Metro image. Use light to enhance station built form and landscape, whilst delivering functional and efficient lighting that creates a safe and high quality experience for all users.

Guidelines

General

- Lighting is to integrate with access, wayfinding and public art strategies.
- Lighting is to reinforce the visibility of station entries as safe and welcoming elements within the local context at night.
- Illumination levels are to be appropriate to the task, be it wayfinding, reading tasks and facial recognition, while creating visual interest within the stations.
- Glare and visual discomfort is to be eliminated through appropriate specification and positioning of luminaires.
- The number of luminaires is to be minimised to aid maintenance and sustainability aspirations.
- A coordinated lighting approach is to provide aesthetic consistency across Sydney Metro by defining station address, public domain areas and attracting customers into station precincts.
- Precinct, corridor and station lighting design should consider public safety, staff movement and navigation, site security and operational requirements.
- Provide market leading energy efficient lighting and lighting control systems.

Public Domain

- Lighting must provide a safe, secure, legible and comfortable environment for all operators and users.
- Provide public space lighting to facilitate diverse uses including night time use of public spaces.
- The Metro stations are to be defined by the application of an iconic, consistent, multi-functional pole and luminaire system.
- To eliminate unnecessary clutter, lighting must be coordinated with all other public domain elements.
- Lighting is to celebrate the station address and pedestrian links with lighting systems that are of an appropriate scale, different to that which defines the precinct streets and street frontages.

Stations

- Lighting is to complement the architectural design and seek to provide an appropriate balance of artificial light and daylight.
- Natural light is to be maximised and artificial lighting is to support natural light levels.
- Natural lighting is to be balanced with adequate shade in summer.

Bulimba Ferry Terminal, QLD. Lighting is integrated with the structural and architectural design.
Source: COX, Copyright: Ross Pottinger

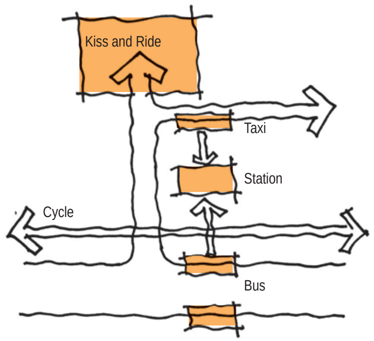
3.3 Connectivity

Safe and convenient connections to and from Sydney Metro stations are an important part of an easy customer experience. Connectivity between different transport modes including walking, cycling, rail, light rail, buses, taxis, kiss and ride and commuter parking, must be legible and easy, acknowledging that Sydney Metro is part of an integrated transport system.

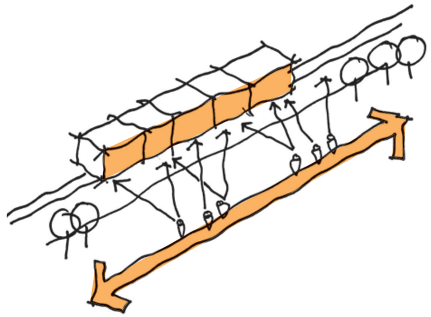
A modal hierarchy that prioritises pedestrian connections guides the Sydney Metro design and ensure the safety and wellbeing of customers and users of the station environs.

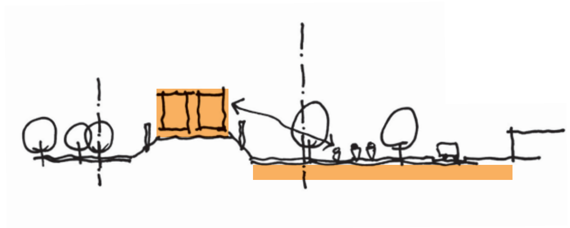
The design of the Sydney Metro stations and station precincts must facilitate safe, welcoming intuitive and accessible connections between transport modes. This part provides guidelines for the following:

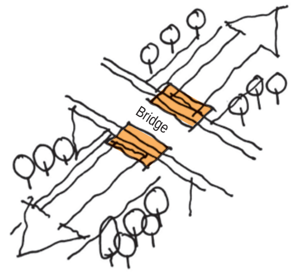
- Line-Wide Connectivity
- Station Interchange
- Pedestrian Movement
- Bicycle Movement
- Vehicular Interface
- Parking



Connected and Integrated


Along Corridor Movement


Commuter Movement



Cross Corridor Movement

3.3.1 Line-Wide Connectivity

Relevant Design Objectives	
1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system
3	Being a catalyst for positive change
4	Being responsive to distinct contexts and communities
5	Delivering an enduring and sustainable legacy for Sydney

Principle

Facilitate safe, legible and enjoyable pedestrian and bicycle connections along the rail corridor between Bankstown and Sydenham stations as well as to surrounding town centres and land uses. The active transport corridor will facilitate alternative transport and healthy lifestyle choices.

Guidelines

- Provide an active transport route along the Sydenham to Bankstown corridor that connects to each station.
- Enable links and connections to the wider cycling and pedestrian network.
- Maximise access, as far as possible, for the full range of potential users on the active transport corridor.
- The design of the active transport corridor is to incorporate the Crime Prevention Through Environmental Design (CPTED) principles. Passive surveillance of the active transport route should be achieved.
- The active transport corridor should utilise existing public lighting such as street lighting and public transport interchange and/or car park lighting where it is available and it meets the appropriate public lighting standard.
- Lighting design along the corridor is to minimise light spill to surrounding receivers and not pose an operational hazard to train operations.
- The pedestrian and bicycle pavements and infrastructure shall be durable and designed to optimise whole of life costs.

Cycle path along the Eastern Busway, Brisbane. Low planting for passive surveillance and wayfinding with clear sight lines.
Source: AECOM, Copyright: Chris Frederick Jones

3.3.2 Station Interchange

Relevant Design Objectives	
1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system

Principle

Provide an efficient, safe transport environment that is part of a fully integrated and accessible transport system, enabling easy connections between transport modes.

Guidelines

- Station planning and design is to be consistent with the following hierarchy of movement modes:
  - Priority 1: Pedestrian, wheelchair and pram movement and access (mobility impaired)
  - Priority 2: Bicycle movement and access
  - Priority 3: Other primary Public Transport services (including Light Rail and Bus movement and access)
  - Priority 4: Taxi movement and access
  - Priority 5: Kiss and ride movement and access
  - Priority 6: Park and ride movement and access
- Station interchange planning and design is to support good access to and between public transport modes for all customers, with connections designed to support efficient and timely interchange for all customers.
- Integration of station precincts with the surrounding urban structure is to facilitate cross movements and through movements, enhancing precinct permeability and access to the transport interchange functions in the locality.
- The stations are to provide a safe, welcoming, intuitive and accessible environment for customers transferring between transport modes.
- Station design is to minimise movement conflicts for customers between key transport modes.
- Station forecourt areas are to accommodate adequate customer access and waiting spaces (as relevant), while ensuring that customer confidence, sense of safety and wellbeing are not compromised.
- The varying spatial requirements of different transport modes, including third party operators, are to be accommodated to avoid user conflicts.
- Point of decision wayfinding signage is to be provided to facilitate walking and cycling choices.

Station modal access hierarchy
Source: TfNSW

Support good access to and between public transport modes.
Source: TfNSW

3.3.3 Pedestrian Movement

Relevant Design Objectives	
1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system

Principles

Provide pedestrian movement systems that clearly connect the stations with their surrounding locality, ensuring they are safe, efficient, accessible, legible and enjoyable.

Ensure the vertical journey is a core element of the station architecture and provides step free access between the street and the platforms.

Guidelines

- The station forecourt and associated areas are to adopt a clear hierarchy of movement functions that favours pedestrians ahead of vehicular circulation, thereby promoting opportunities for public transport patronage, walking and cycling.
- Station precincts are to provide pedestrian routes that connect people with places they want to go (desire lines) and provide clear sight lines through open, uncluttered spaces along pedestrian desire lines between key destinations, including between transport modes.
- Pedestrian movements are to accommodate an appropriate level of service in all areas of the station. Precinct designs are to optimise the variety of movement functions in order to minimise potential conflicts.
- Circulation systems are to respond to context and reinforce the character of precincts so they are easy and efficient to navigate.
- Design decisions affecting movement planning are to consider varying customer usage patterns including commuters, customers with disabilities, station employees, tourist customers and non-travelling visitors.

Kogorah Station and precinct upgrade. Well integrated with precinct and accommodates pedestrian flows.
Source: COX

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3.3.4 Bicycle Movement

Relevant Design Objectives

2	Being part of a fully integrated transport system

Principle

Prioritise bicycle movement consistent with the modal access hierarchy by providing optimum connectivity and convenient and accessible bicycle parking at stations to accommodate current and future demands. Enable bicycle connectivity between stations along the rail corridor.

Guidelines

- Bicycle paths to/from stations are to be located so as to enable connections with existing and future regional and local government bicycle networks (by others).
- The design of bicycle paths and routes connecting directly to/from stations are to meet future demands, be legible and be safe for bicycle riders and other users.
- Access to bicycle networks is to be easy, enabling the comfortable flow of bicycle traffic.
- Conflicts between pedestrians and cyclists at stations are to be designed out, particularly at high activity zones such as station entries and retail areas, with priority to pedestrians.
- Provide safe, accessible and convenient bicycle parking storage facilities, with active and passive surveillance and weather protection, connected to existing bicycle networks where possible.
- Sheltered and Opal accessed bicycle parking at stations is to be placed directly adjacent to movement paths where possible to provide clear and legible access, without compromising safe, accessible paths of travel for customers with mobility and vision impairment.
- Design for bicycle facilities is to give priority to bicycle safety at road interfaces where possible.

Bicycle Parking

- Secure access bike parking enclosure and roofed sheltered parking areas should be designed as single integrated structure.
- Bicycle parking is to be designed as part of the suite of station buildings and public domain elements, in terms of scale and architectural expression and be designed to the same standard as other station buildings.
- Bicycle parking should be integrated with other functions, such as ticketing and information, community or retail facilities, where feasible.

Provide for people with bicycles throughout the intermodal connections.
Source: TfNSW. Copyright: Glenn Duffus Photography

Bicycle parking hub, Woy Woy
Source: TfNSW, Courtesy of The Circus Group 2016

3.3.5 Vehicular Interface

Relevant Design Objectives	
2	Being part of a fully integrated transport system

Principle

Reinforce a legible hierarchy of safe vehicular streets within the established street network that respond to the varying customer and operational requirements for pedestrians, bicycle and vehicular movements in accordance with the modal hierarchy.

Ensure there is no net loss of commuter parking spaces on rail corridor land along the length of the corridor.

Guidelines

- The design of stations and associated station precinct is to respond to the character of established streets and variations in carriageway width, on-street parking, existing and planned cycle ways, landscape/ street tree planting and pedestrian amenity.
- Streets are to be designed as urban places with a high level of pedestrian amenity, allowing for inherent traffic calming measures where possible.
- Accessible car parking spaces are to be located as close to the station entries as possible. Some existing accessible parking spaces may be used.
- Modifications to existing roads are to consider:
  - Agreed adjustment of existing roads with relevant authority
  - Number of traffic lanes
  - Length and type of slip lanes
  - Intersection types and configurations
  - Signalling requirements
  - Speed environments, traffic calming measures
  - Bus layover zones
  - Kerbside zones
  - Shared zones
  - Cycling
  - Footpaths
  - Crossings
  - Mobility and DDA compliance
  - Street trees and landscaping
- Changes to streets, footpaths and bicycle paths are to contribute to the quality and character of the existing urban area and contribute positively to the customer experience.
- Vehicular traffic planning is to be integrated with the built form and spatial planning of precincts.
- Provide for bus stops close to the station in accordance with the modal hierarchy, bus movements where buses operate on streets adjacent to station entries and safe and accessible paths to bus stops.
- Taxi, kiss and ride and park and ride spaces are to be located in accordance with the modal hierarchy.
- Service vehicle access for all precinct functions is to be addressed as part of the broader station precinct movement strategies.

Note - further guidelines on Service Vehicle Access are set out in Section 4.5.7

Cheltenham Station
Source: COX

4 Elements

About this Section

This section provides guidelines for developing the detailed elements of the public domain around and within stations including connecting customer areas through station entries.

The guidelines for the design elements in this part of the document are arranged according to the following topics:

- Stations
- Station Public Domain
- Rail Corridor
- Operation and Services

More detailed design guidelines and key requirements for each of these elements will be included in the scope and performance documents during the procurement stage.

Thomastown Station, VIC. Legible station entry integrated with the public domain.
Source: COX

4.1 Stations

The Sydney Metro stations are part of a wider system requiring consistency between station planning, operations and architecture. Each station will take on a unique identity that relates to its locality, expressed through the station design. The interface between the station and surrounding context is critical in providing an integrated and legible transport system that is easy for the customer to use.

The design of each station must be framed around the benefits to or impacts upon the customer experience. Station entries, platforms and circulation elements must be designed to meet operational requirements while ensuring an easy customer experience. Stations are public buildings and all circulation elements, finishes and fittings must be of a robustness and quality associated with outdoor public spaces as well as suitability for the rail environment.

This part provides guidelines for the following station elements:

- Station Typology
- Station Entries
- Station Canopies
- Platforms
- Circulation Elements
- Flooring
- Internal Walls and Ceilings
- Lighting

Craigieburn Railway Station, VIC.
Source: COX

4.1.1 Station Typology

Relevant Design Objectives

1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system
5	Delivering an enduring and sustainable legacy for Sydney

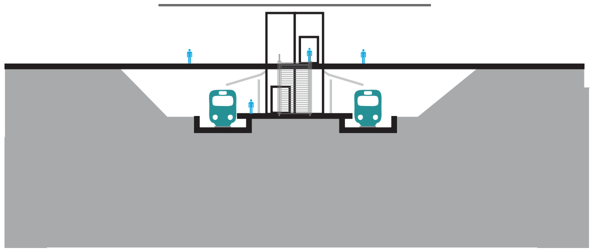
Principle

The designs are to provide consistency between station planning, operations and architecture across the differing station typologies that will be adopted between Sydenham and Bankstown. There will be two principal typologies that relate to their construction type:

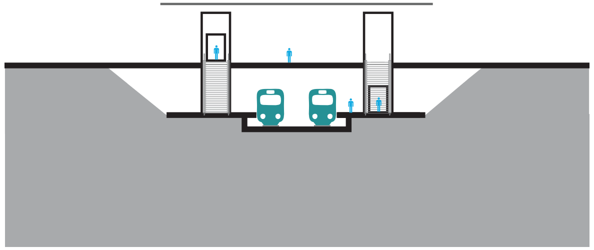
- ***Island platform***
- ***Side platform***

Guidelines

- The stations are to be integrated within the adjoining precinct to provide direct and safe accessibility to the station entry.
- The station is designed to enable integration with existing and future local development opportunities within adjacent sites as relevant.
- Station designs are to provide a seamless transition between transport modes.
- Stations must be easy and safe for all to use regardless of physical mobility; able bodied customers, wheelchair users, carers with strollers, the visually and cognitively impaired must all be provided with equal access.
- The Sydney Metro stations should maximise consistency in the key functional elements of the architecture.
- Integration of operational and customer facilities is to be consistent across the two typologies providing a high quality and consistent experience for all users.
- Design to minimise level changes between the street and station entries and to platforms.
- Maximise access to natural light and ventilation.
- All entries and concourses are to be open and transparent, generous and inviting.
- Design for efficient customer circulation and intuitive wayfinding to and from station entries and platforms.
- Where stations are located in cuttings, designs are to maximise soft landscaping in cuttings and embankments to minimise hard surfaces and vertical walls.
- Allow for flexible commercial opportunities including pop ups, start-ups, micro and small businesses in station plazas.
- Opportunities to provide for active uses and frontages should take priority over service related structures.
- Expression of major structural elements is to be considered in station design.
- Consider the role of station elements in supporting a night time economy, including retail areas, lighting, and use of public spaces by the community.



ISLAND PLATFORM STATIONS
DULWICH HILL
BELMORE
LAKEMBA
BANKSTOWN



SIDE PLATFORM STATIONS
SYDENHAM
MARRICKVILLE
HURLSTONE PARK
CANTERBURY
CAMPSIE
WILEY PARK
PUNCHBOWL

4.1.2 Station Entries

Relevant Design Objectives

1	Ensuring an easy customer experience
4	Being responsive to distinct contexts and communities
5	Delivering an enduring and sustainable legacy for Sydney

Principle

Station entries including canopies and concourses are to create a strong and consistent line-wide visual identity to the station environments and be designed as intuitive interchange spaces for customers.

Guidelines

General

- Entrances to stations including canopies and concourses are to provide a consistent line-wide identity for Sydney Metro and are to be clearly visible from the immediate area.
- Designs are to provide a legible station entry integrated with public domain with clear sightlines to the station from the surrounding precinct, particularly where a station has been moved from its existing location.
- Station entries are to be oriented towards established communities and active streets to reinforce wayfinding and identity .
- Station entries are to be legible from the street and public domain and are to minimise long blank walls through articulation of the built form.
- Station entries are to incorporate canopies/awnings as appropriate to provide weather protection for customers, community information, amenities, and ticketing equipment, gateline and appropriate queuing zones.
- Entry concourses should be clutter-free with clear and simple directional signage, simple volumes and flush continuous materials with components that support wayfinding.
- Entry spaces are to be well lit, bright and welcoming to enhance customer experience providing a safe, open environment that has good permeability and clear sight lines from inside and outside the station.
- Adequate space should be provided to meet patronage demand and to provide clear zones for queuing at Ticket Vending Machines (TVMs) and gatelines, including during special events, separate to paths of travel.
- Station entries are to provide adequate space for customers to wait and meet without impeding pedestrian flows.
- Columns are to be minimised and carefully positioned not to obstruct key sightlines or pedestrian movement, particularly for the mobility or visually impaired.
- Lighting, communication, wayfinding and information and security systems are to be well integrated with equipment and recessed where possible.
- Unobtrusive maintenance access is to be provided.
- The materials palette is to be of high quality and is to integrate with surrounding high quality public realm context.
- Integration of permanent public art within the station architecture is to be considered. Art should act as a visual cue to enhance wayfinding.

Craigieburn Railway Station, VIC. Station entry canopy provides weather protection for customers.
Source: COX

4.1.3 Station Canopies

Relevant Design Objectives

1	Ensuring an easy customer experience
4	Being responsive to distinct contexts and communities
5	Delivering an enduring and sustainable legacy for Sydney

Principle

Station canopies are to create a strong overall visual identity in the station environment, sitting comfortably within their context and providing weather protection for all queuing zones. Platform canopies are to provide comfort for waiting and alighting customers.

Canopies, roofs and soffits are key elements that should share common materiality and form across all stations to provide a common line-wide identity.

North Melbourne Station, VIC. Canopy over concourse
Source: COX

Guidelines

General
- Natural daylight to the station environment is to be maximised for well-being and comfort.
- Canopies with extensive glazing are to consider solar control measures.
- Canopy designs are to ensure reduced heat transmittance and ultraviolet radiation.
- Canopy design is to contribute positively to the built environment by enhancing the immediate public domain.
- Canopy detailing must consider impacts of bird nesting.
- All canopies are to consider:
  - Modular and prefabricated systems
  - High quality material finishes
  - Integration of acoustic treatments
  - Edge treatments are to be well-considered
  - Integration of services (CCTV, PA, signage, lighting etc.)
  - Drainage and downpipe integration – concealed downpipes
  - Cleaning and maintenance requirements
  - Integration with photovoltaic cells

Entry and Concourse Canopies
- The canopy design is to create a recognisable identity for all stations along the Sydenham to Bankstown line.
- Entry canopies are to be clearly visible from the surrounding public domain and promote a sense of arrival.
- Entry canopies are to provide weather protection for customers and community information, amenities (ATMs and vending machines), Opal top-up/purchase, gateline and appropriate queuing zones.

Platform Canopies
- Platform canopies are to provide adequate coverage during peak periods and an even distribution of covered areas.
- Platform canopies are to provide weather protection to vertical transport and platforms.
- The canopy is to the platform edge to provide weather protection.
- Column supports are to be located to minimise obstructions
- Access to daylight is to be a key feature of the design of the canopy while balancing weather protection.
- New platform canopies are to be sensitively integrated with retained heritage platform buildings and canopies.

Roof Lights
- The appearance and function of roof lights is to be suitable for a rail environment and reinforce the Sydney Metro identity.
- Roof light design is to consider:
  - Material consistency
  - Slope of transparent surfaces to minimise build-up of dirt
  - Cleaning and maintenance access
  - Any visible fixings to be stainless steel
  - Integration with signage
  - Dedicated zones for equipment and cabling
  - Constructability and replacement requirements

4.1.4 Platforms

Relevant Design Objectives

1	Ensuring an easy customer experience

Principle

Platform designs are to maximise efficiency, safety and provide a high level of service and an easy customer experience.

Guidelines

- Platforms are to provide efficient and safe access to the Metro service through good sightlines and generous circulation.
- Platforms should prioritise efficient train loading and unloading in relation to fixed platform elements.
- Vertical transport distribution and position on the platform is to be coordinated with the demand and movement patterns of customers.
- Platforms are to be free of recesses and indentations which could offer hiding places and litter traps, disrupt continuous paths of travel for the visually impaired and hinder CCTV coverage.
- All platforms are to provide platform screen doors and barriers.
- Emergency egress is to be provided.
- Platforms should establish a strong relationship with the vertical circulation zone through lighting and material palette selection.
- Platforms should minimise structures and columns to maximise sightlines and customer waiting and circulation space.
- Platforms are to be safe and weather protected while maximising outward views, natural light and ventilation.
- Platforms are to include customer seating, positioned to ensure safety and maintain pedestrian flows.
- Platforms are to have minimal gaps between trains and platform edges
- Platforms are to provide level access, wheelchair waiting positions and those with luggage and bulky items.
- Platforms are to integrate with platform edge barriers.
- Platforms are to provide efficient wayfinding and signage
- Platforms are to provide level and gap free access to trains.

Platform Screen Doors (PSDs)

- Platform screen doors are to be minimal and elegant, seamlessly integrating customer information and supporting the station servicing requirements.
- Platform screen doors must run along the full platform and the integration of fixed platform screen end walls must be well considered.
- Fixed platform screens are to be the same height and material as platform screen doors.
- The architectural language is to be consistent with the platform screen doors and the door and fixed panels are to be set out on a consistent grid.
- Stations are to integrate the following PSD design considerations:
  - Be full height
  - Run full platform length
  - Integration of the end walls is to be well-considered
  - Security requirements
  - Modularity of units - constructability, repair and replacement
  - Interface with other wall, floor and ceiling junctions.

Artists impression of platform at Cudgegong Road Station maintaining clear sightlines and generous circulation
Source: TfNSW

4.1.5 Circulation Elements

Relevant Design Objectives	
1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system

Principle

Enable step free access between the street and the platform via lifts and stairs that are integrated with the station design.

Guidelines

- All Sydney Metro platforms are to be served by lifts, which are to provide direct access from entry concourse to platform level .
- All circulation elements are to provide a means of safe movement of people in and around the stations.
- Ramps are favoured in the transition from concourse to public domain areas where lifts can be avoided.
- Where ramps and lifts are provided as an alternative to stair access they must not result in a longer journey than the primary circulation route.
- Lifts are to integrate into each station designs and be strong architectural elements in their own right to promote the inclusion of customers using step free circulation elements.
- All circulation elements are to incorporate high quality materials that contribute to the Sydney Metro identity.
- Weather protection must be provided over vertical circulation elements.

Note - further design guidelines on accessible pathways are set out in Section 4.2.2 and further guidelines on station canopies set out in Section 4.1.3.

Chatswood Transport Interchange, NSW. Good example of a glazed lift and shaft
Architect: CoxDesignInc.
Source: COX

4.1.6 Floor Finishes

Relevant Design Objectives	
1	Ensuring an easy customer experience
4	Being responsive to distinct contexts and communities
5	Delivering an enduring and sustainable legacy for Sydney

Principle

Ensure the safe, efficient movement of pedestrians, including people with disabilities, through high quality and robust flooring design suitable for the station environment.

Guidelines

- Flooring is to provide a safe and robust solution, suitable for the station environments. Types of flooring include those appropriate to public areas and others to areas of the station where special flooring is required.
- Flooring is to form a part of the Sydney Metro line-wide identity and maximise operational efficiencies.
- Flooring selection is to consider long term wear and tear, maintenance, sustainability objectives including dematerialisation and embodied energy, and future replacement as an important consideration in the design process.
- Flooring is to consider the urban realm context of the station, creating a complementary transition between the public domain and station.
- Flooring is to provide a clean, attractive and uniform appearance throughout the stations and is to be integrated with the broader station materials palette to aid wayfinding.
- Flooring pattern and design is to accentuate movement.
- Flooring materials must be designed for all weather usage, not contribute to customer discomfort (such as heat and glare), and meet slip resistance requirements.
- Ensure flooring material selection responds to the local microclimate and incorporates opportunities to reduce heat island effects, including (as appropriate) light coloured finishes while considering the impact of glare.
- Flooring is to be the same on each side of the station gateline.
- A smooth transition must be provided between abutting paved surfaces, free of trips and hollows.

Coordinate interior and exterior public domain pavements.
Source: AECOM.

Flooring provides a clean and attractive appearance. Artists impression of concourse flooring at Sydney Metro Northwest
Source: TfNSW

4.1.7 Walls and Ceilings

Relevant Design Objectives

1	Ensuring an easy customer experience
4	Being responsive to distinct contexts and communities
5	Delivering an enduring and sustainable legacy for Sydney

Principle

The design of wall and ceiling elements is to contribute to the Sydney Metro line-wide identity and be suitable for the station environment, and appropriate to heritage buildings and local context.

Guidelines

General

- The appearance and function of the walls is to be suitable for a rail environment and reinforce the Sydney Metro identity.
- Wall systems and details are to respond to their location, function and acoustic environment.
- Ease of access, maintenance and replacement of walls sections is to be considered.
- Robust cladding materials and finishes are to be selected in response to the local environment and conditions.
- Opportunities for public art, feature walls or green wall treatments should be explored through the form, finish, angle, articulation, and materiality of walls to create an identifiable station element. This may be used in vertical circulation zones, and used to accentuate the customer pathways and establish a strong architectural language, and enhance wayfinding.
- Walls and ceilings are to contribute to the high quality station environment and customer experience.
- The materials palette is to balance a calm and neutral quality with vibrant materials to aid wayfinding and accentuate movement.
- Use of colour/texture is to assist in legibility and wayfinding.
- Wall and ceiling detailing is to take into consideration the integration of station assets such as signage, fixtures and machines.
- Wall surfaces are to consider anti-vandalism / anti-graffiti treatments.
- Walls are to provide light coloured surfaces for effective indirect lighting.
- Services buildings and structures at stations must be designed to the same standard as station buildings.

South Morang Rail Extension, VIC. Calm and neutral materials with integrated services.
Source: COX

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4.2 Station Public Domain

The public domain is a significant component of the door-to-door journey for Sydney Metro customers. The design quality of station precincts, forecourts and streetscapes outside station entries will therefore be of paramount importance to the overall public experience and perception of the new system. This has implications for the detailed design stages of the project with a range of architectural and engineering structures, landscaping elements and operational equipment that will need to be co-ordinated to ensure that coherent and distinctive station environs are delivered.

Station architecture will have a consistent line-wide identity, with a unique response to the locality expressed in the public domain. The interface between the station and surrounding streetscape needs to be well integrated and functional as part of the provision of robust and legible interchanges at Sydney Metro stations.

In some cases, the creation of better streetscapes and civic or community spaces adjacent to the project alignment and stations will be for other government authorities to pursue at local or state level, with assistance from the Metro project team and/or the private sector. Design guidelines specific to those urban realm opportunities will be more appropriately considered on a site by site basis as they are identified.

Key elements of the public realm around Metro stations and the alignment that are considered in this part of the document include:

- Plazas
- Accessible pathways
- Furniture
- Plaza Walls and Fences
- Station Service Facilities

Guidelines for public domain between stations along the rail corridor are detailed in Section 4.3.

4.2.1 Plazas

Relevant Design Objectives

1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system
4	Being responsive to distinct contexts and communities
5	Delivering an enduring and sustainable legacy for Sydney

Principle

Provide new and upgraded plazas that include hard and soft landscape areas that are appropriate to plaza functions, local conditions, and consistent with the existing and varied character of the Sydenham to Bankstown Line while contributing to line-wide legibility and a clear identity for Sydney Metro City & Southwest.

Guidelines

- Plaza design must achieve a safe, clean, clutter free and functional environment that provides easy access for all users.
- Plaza areas and station approaches must be distinctive in design and highly visible from adjacent high streets and town centres.
- The public domain and plaza works associated with the stations must integrate seamlessly with the existing built environment and streetscapes of each centre while also considering the planned future context of stations.
- Plazas are to be designed to provide shade during summer and good solar access in winter
- Plaza design is to consider the reduction of heat island effects with the inclusion of planting including (as appropriate) light coloured finishes without ignoring the potential for glare.

Pavements

- The materials palette is to contribute to a clear Sydney Metro identity and yet be appropriate to a suburban station environment.
- Materials and finishes are to be high quality, durable be designed for ease of maintenance.
- Use of colour/texture and paving pattern and arrangement to assist in wayfinding and in highlighting the main direction of travel should be considered.
- Materials are to minimise slips, trips and falls.
- Consider reuse of materials salvaged from demolition e.g. in public space landscaping.
- Integrate water sensitive urban design including permeable pavements, where feasible.
- Paved surfaces are to be well drained to avoid water pooling.
- In general, driveway locations are to be separated from active frontages, collocated and kept to a minimum. Driveways are to be visually highlighted against adjacent pedestrian or shared paths through contrasting paving layout, materials or finish.

Planting

- Plant species must be suited to local environmental conditions and urban context.
- Planting arrangements and species are to suit the scale of each public domain area without compromising pedestrian capacity and circulation around stations.
- Plaza planting areas should employ passive irrigation and water sensitive urban design where feasible.
- Screen planting is to be used to mitigate the visual impact of blank building walls, retaining structures, noise walls and service facilities.
- Suitable street tree species are to be used, to reinforce spatial movement, connectivity with adjacent areas, civic quality, visual continuity and/or identity and character.

Afghan Bazaar Cultural Precinct, Dandenong, VIC. Public spaces should draw upon and celebrate the unique cultural identities of the locality
Source: HASSELL

4.2.2 Accessible Pathways

Relevant Design Objectives	
1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system

Principle

Provide pathways to and from station entries and facilities that are accessible, safe and comfortable for all users.

Guidelines

- A system of appropriate pathway surfaces, widths and gradients is to provide safe and equitable pedestrian access throughout the public domain and to link transport modes.
- Station precincts must be easy and safe for all to use regardless of physical mobility; able bodied customers, wheelchair users, carers with strollers, and the visually and cognitively impaired should all be provided with equal access.
- Stairs are to be avoided as far as possible as they reduce opportunities for universal access.
- A continuous accessible path of travel must be provided from any accessible car park space linking footpaths, public transport set down areas, accessible passenger loading zones and any adjacent associated buildings.
- Where stairs are used, they must be short in length, easy and safe to use.
- Clearly legible alternative circulation routes using accessible lifts and ramps must be provided in addition to the use of stairs. These alternatives must be as close as possible and not isolated from the primary circulation route and easy to identify.
- Ramps may provide opportunities for universal access; however, where possible, seek alternative means of effecting level changes, for example, by altering the path of travel.
- Colour, texture, lighting, finishes and customer information is to be used selectively to further define paths of travel, circulation spaces and the location of key facilities.
- Pathways are to be well drained to avoid water pooling.
- Tactile Ground Surface Indicators should be used on paths of travel to warn customers with vision impairment of hazards and assist wayfinding where required.
- Where possible, provide a consistent, clear path of travel for customers with vision and mobility impairments by keeping one side of paths of travel clear of fittings and fixtures.

Milton Ferry Terminal, QLD. Ramps provide equal access for all customers. Integrated seating provides rest points along paths of travel.
Source: COX, Copyright: Chris Frederick Jones

4.2.3 Furniture

Relevant Design Objectives

1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system

Principle

Furniture and fixtures are to provide respite, safety, comfort, services and functionality to public spaces, as well as contributing to the spatial and aesthetic composition of station plazas.

Guidelines

General

- Furniture and fixings are to be robust, high quality and attractive and contribute to the Sydney Metro identity.
- Furniture and fixings are to be arranged to assist in the delineation of functional and circulation zones.
- Elements in public areas (bins/seating/drinking fountains/bollards) are to adopt a rational and ordered layout that minimises visual clutter and optimises safe, accessible paths of travel.
- The use of bollards should be minimised. Safety and access to station precincts should, where practical, be achieved by integrating vehicle protection with street furniture, landscaping or public art.
- All components should be accessible and integrated with station design. Furniture and fixtures must accommodate all users with a wide range of physical abilities.
- Street furniture selection and arrangement should facilitate active plaza uses and informal recreation.

Weather Protection

- Weather protection is to be provided at all transport interchanges.
- Shelters must be robust and form part of the suite of furniture, fixtures and associated station architectural elements. The integration of solar panels in shelters is to be investigated.

Seating

- Seating placement should provide resting points on the customer's journey, in accordance with requirements of the Disability Standards for Accessible Public Transport, and avoid impeding easy circulation.
- Seating is to be located along main paths of travel adjacent to entrances, transit shelters and meeting points and no more than 60m apart.
- Seating should be located in both shade and open areas, with weather protection provided where possible.
- Seating is to be located away from street corners and arranged in accordance with CPTED principles.
- The location and grouping of seating and other elements is also an opportunity to help create meeting places and a sense of place.

Handrails and Balustrades

- Handrails and balustrades should assist in safe, accessible customer movement and be consistent in material and quality with fixtures across Sydney Metro City and Southwest.

Waste Bins

- Bins should be consistent throughout southwest Metro line.
- Bins are to be located to minimise litter while considering the attractiveness of the station precinct.
- Facilities should aid waste separation and recycling.

Seating can be integrated with landscape elements where it does not impede customer flows. Flinders Street Mall, Townsville
Source: COX

4.2.4 Plaza Walls and Fences

Relevant Design Objectives	
1	Ensuring an easy customer experience
4	Being responsive to distinct contexts and communities
5	Delivering an enduring and sustainable legacy for Sydney

Principle

Wall and fencing element design is to be a system which can be applied across the corridor and to station sites with a high quality, robust and durable form that is representative of the Sydney Metro image and each station's context.

Guidelines

- The appearance and function of external walls and fencing is to be suitable for a rail environment and reinforce the Sydney Metro identity.
- Location, scale and articulation of external walls and fences are important elements of the public realm. Their design is to be an integral part of the urban design of station areas and corridor to minimise excessively long unarticulated lengths, bland and unappealing frontages.
- Wall and fencing systems and details are to respond to their location, context, function and acoustic environment.
- Ease of access, maintenance and replacement of walls and fencing sections is to be considered.
- Robust cladding materials and finishes are to be selected in response to the local environment and conditions, and sustainability objectives including dematerialisation and embodied energy.
- Feature walls are to be used to accentuate customer pathways and establish a strong architectural language at stations, employing artworks where appropriate.
- The materials palette should balance a calm and neutral quality with vibrant materials to aid wayfinding and accentuate movement.
- Use of colour/texture should assist in legibility and wayfinding.
- Retaining walls are to attempt to knit into adjacent landscape formations, or with adjacent elements.
- Fencing throughout station precincts and public domain areas must avoid creating dead ends or sightline conflicts.

Appropriate scale and articulation of walls and fences are important in the public domain.
Source: COX/HASSELL

4.2.5 Station Service Facilities

Relevant Design Objectives

4	Being responsive to distinct contexts and communities

Principle

The rail infrastructure elements for stations and service facilities must be integrated into the design, whilst being able to be easily maintained. Service buildings (including Traction Power Substation) in stations and the public domain shall be designed to the same standard as other station elements. These buildings also need to be sensitively designed. Traditional railway architecture achieved this very well.

Guidelines

- Service facilities are to form an integrated solution with the station architecture and precinct taking into account the scale, context and purpose of the structure.
- Design integrity must be addressed through careful positioning of equipment.
- Similar materials and components as used in station design are to be selected where appropriate to support the Sydney Metro identity.
- Service elements visible in the public domain need to consider impacts including visual, environmental and acoustic on the streetscape.
- Each facility/service building is to respond appropriately to its local context yet maintain a distinct Sydney Metro identity.
- Service elements located in public areas of the station and surrounds are to be integrated with other functions such as public facilities, ticketing and information, fire stairs, community facilities or retail to minimise the impact of the services on the station precinct, where feasible.
- Integrate service facilities with landscaping and topography to mitigate any negative streetscape impacts; provide landscape screening to all buildings elevations visible from streets and public areas.
- Design of service facilities is to consider opportunities to use vertical green walls.
- The designs should be coordinated with civil engineering and rail systems requirements to ensure efficient, economical designs.
- The designs are to provide efficient space planning of all service requirements to minimise bulk and scale of service buildings.
- Access for maintenance and replacement of plant must be considered including personnel access for regular maintenance tasks.
- The designs should allow for safe access and egress to all areas of services buildings.
- Access requirements should be considered to minimise negative impact on associated public functions.

Caufield Station, VIC. Platform service building
Source: Lovell Chen

4.3 Rail Corridor

The rail corridor is a significant spine that runs through 11 established communities and urban settings. The design approach to the corridor will ensure a safe and secure corridor, establish a line wide identity, recognise the corridor as part of the door to door customer journey and be responsive to the environments it passes through.

The rail corridor will have a strong landscape quality, with a planting palette that draws on the pre-existing native vegetation communities in a design that responds to the variable nature of the corridor. Built elements in the corridor such as retaining walls, protection screens and noise walls must be part of an integrated line-wide design, one where the range of structures are designed in relation to each other and to their urban and landscape setting. The form and placement of structures should allow for adequate landscape screening where visual mitigation is required. Security and segregation fencing must provide the required security for corridor infrastructure, and safety for maintenance operations, while maximising visual openness across and along the corridor.

Connectivity across the corridor occurs at existing bridges, overpasses and underpasses, and in some locations, new station concourses; all of which are, or will become, important urban links for local communities. Many of the existing bridges are an important part of the heritage fabric of the line. The addition of new elements such as vehicle barriers and anti-throw screens must be sensitively designed with this in mind.

Key elements of the rail corridor that are considered in this part of the document include:

- Cuttings and Earthworks
- Corridor Landscape
- Corridor Walls and Fences
- Bridges, Over Passes and Under Passes
- Rail Corridor Services

Rail Corridor with Sydney Trains service
Source: TfNSW, Photographer: Simon Freeman 2013

4.3.1 Cuttings and Embankments

Relevant Design Objectives

1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system
4	Being responsive to distinct contexts and communities

Principle

Visually integrate earthworks into their landscape setting as much as possible to keep engineered structures to a minimum.

Guidelines

- Where cut embankments are required, a combination of engineered slopes and low retaining walls are to be used to create an integrated, 'sculpted' landform, suited to the setting.
- Planted cut or fill battered slopes are to be used wherever possible and are preferable to walling solutions.
- All engineered earthworks are to make transition between areas of cut to areas of fill parallel to the main corridor alignment.
- All formations are to be gently rounded out at both top and bottom of slopes, and at each end of each formation, in order to achieve a 'natural' transition into adjacent landforms.
- Visually all earthworks should sit lightly in their context, exhibiting a 'natural fit' within their landscape setting by integrating planting and reducing gradients wherever possible.
- Embankments and cuttings are to be landscaped with native planting to reinforce the green connection along the corridor. Grading of embankments is to be accessible for maintenance.
- Erosion control matting is to be used on batters and embankments to aid soil stabilisation and promote vegetation growth along the corridor.

Combination of engineered slopes and low retaining walls to achieve a sculpted land form.
Source: COX/HASSELL

Inner Northern Busway, Brisbane. Ensure earthwork batters sit lightly in their context, exhibiting a 'natural fit' with their landscape contexts.
Source: AECOM

4.3.2 Corridor Landscape

Relevant Design Objectives	
1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system
3	Being a catalyst for positive change
4	Being responsive to distinct contexts and communities
5	Delivering an enduring and sustainable legacy for Sydney

Principle

Provide a landscape design that considers the variable nature of the corridor as well as that of existing adjacent open space, streetscapes and potential new areas of open space.

Guidelines

- Clear sightlines to Metro stations and at adjacent roads and junctions, are to be maintained through the application of CPTED principles.
- The corridor landscape wherever possible should be integrated with adjacent open space.
- Landscape design is to consider the variable topography and ground conditions of the corridor.
- Landscape design should incorporate water sensitive urban design initiatives where feasible.
- Corridor landscaping is to consider the prevailing physical conditions, soils and climate of southwestern Sydney, be drought tolerant and low maintenance.
- Planting adjacent to existing bushland or areas of extant indigenous vegetation is to be derived from naturally occurring appropriate species to augment these areas.
- Wherever possible, healthy street plantings should be maintained and protected.
- Screening planting is to be used adjacent to retaining and noise walls, where clearance offsets permit, to mitigate their visual impact.

Graceville Rail Corridor, NSW. Noise Walls
Source: AECOM.

4.3.3 Corridor Walls and Fences

Relevant Design Objectives

1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system
4	Being responsive to distinct contexts and communities

Principle

Visually integrate fences and walls into the rail corridor and urban or landscape setting as part of a coordinated line-wide design, and ensure adequate security of corridor infrastructure and safety of its users.

Guidelines

General

- Fences and walling, including retaining walls and noise walls, must be designed as a unified suite of materials that relate to the station precincts and corridor. The visual appearance along the corridor for customers as well as for residents helps create a whole of corridor identity.
- The design, detailing and materials including joints, junctions, fixings, and placement of support posts, is to be fully coordinated with all other urban elements, including with retaining walls, noise walls and bridge throw-screens.
- Corridor walls and fences are to be robust and suitable to the rail environment, considering maintenance and future replacement.
- Material and system selection to consider sustainability objectives including dematerialisation and embodied energy.
- Vandalism and graffiti is to be considered in the design of corridor walls and fences finishes and maintenance.

Fences

- Security fencing is to include permanent gated access at controlled locations. Fencing and gate locations are to be coordinated with strategic emergency access and egress points.
- Fencing system designs are to be as consistent as possible. Fencing design is to be minimal and contemporary, with a common modularity, materiality and appearance through the choice of readily available materials, considering whole-of-life and replacement costs.
- Fencing design is to deter climbing, providing no footholds.

Noise Walls

- Noise wall panels are to comprise robust, vandal-resistant materials and be resilient to damage by adjacent planting.
- Reduce the apparent scale and visual impact of noise walls with careful planting to both sides of noise walls where possible.
- Overshadowing of noise walls to adjacent residential properties must be minimised. The use of transparent materials is to be considered to mitigate overshadowing impacts where appropriate.
- The use of textures and patterns is to be avoided, noise walls are to consist of simple, contemporary, modular panel systems that are easily read at speed from a moving train.

Retaining Walls

- Retaining walls and related elements are to be designed as a unified composition and be integrated with the adjoining landscape (as appropriate) and other components such as fencing, guard rails, steps and other walls.
- Enable access for maintenance and cleaning.
- Existing sandstone cuttings are to be maintained and enhanced where possible. New cuttings are to respect the natural geology of the area.

Trackside Walls

- Trackside walls within the station precinct are to be designed and treated as part of the station architecture.
- Trackside wall materials are to have smooth finishes that do not attract dust and dirt.
- Trackside wall design is to consider constructability, maintenance and access.

4.3.4 Bridges, Over Passes and Under Passes

Relevant Design Objectives

1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system
4	Being responsive to distinct contexts and communities

Principle

Upgrade bridges in a way that sensitively manages old with new, integrating all architecture, engineering and rail systems requirements while establishing a coordinated, elegant family of bridges, overpasses and under passes that respect their heritage identity.

Bridges, over passes and under passes are to establish functional and clear connections across the rail corridor, connecting communities and contributing to placemaking.

Guidelines

- Bridges, over passes and under passes provide safe and easy connections across the rail corridor.
- The design of bridges, over passes and under passes are to be of high quality materials appropriate to context and consider opportunities for landscaping
- Bridge design is to be fully coordinated with associated structures to visually integrate with their setting. Visual continuity contributes to the overall success of the urban design outcome for the corridor.
- The design of bridges is to present smooth, clean lines and have a minimum structural depth that is consistent with their spans and method of construction.
- Bridges are to be designed as holistic, coherent and symmetrical structures considering the proportion of all elements of the structure including parapets, barriers, fencing, protection screens and other critical elements.
- The junction between bridges and adjacent retaining walls are to establish a clear separation from, or integration with, the bridge girder.

Protection Screens

- All overbridges are to have protection screens, either entirely new or affixed to existing masonry parapets.
- The design of protection screens is not to result in an enclosed ‘cage’ effect. Protection screens are to be fully integrated with other bridge and abutment elements.
- The modular screen panels are to be integrated with the bridge parapet detail.
- Protection screens are to be integrated with the design of the road bridge and adjoining station fences as a whole.
- Screens are to be designed with post spacing to provide a pleasing and ordered visual relationship with other road bridge details, including safety barrier posts, lighting columns and parapet joints; and be provided with fixing points which are in line with the double rail barrier to minimise visual clutter.

Hume Highway, Albury NSW.
Source: AECOM.

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4.3.5 Rail Corridor Services

Relevant Design Objectives	
2	Being part of a fully integrated transport system
4	Being responsive to distinct contexts and communities

Principle

Rail services should be low maintenance, seamlessly integrated into the corridor design and ensure safe rail operations. The design should allow for discrete placement of services to create a clutter free corridor where possible, and incorporate landscape treatments to screen prominent service utilities, to create a positive travel experience.

Guidelines

- Overhead wiring masts, tensioning structures, communications equipment and localised refuges must be located in a dedicated zone within the rail corridor, as close as possible to the rail track infrastructure, and located to minimise the visual impact and spatial width requirement of the rail infrastructure within the urban environment.
- Combined services route (CSR) must be rationalised and designed to be integrated with landscape elements, including retaining walls and features where feasible, to minimise the visual impacts, particularly in station environments.
- Consider integration of the CSR with fences, masts and landscaping to reduce visual impact and rationalise the design of services and structures.

South Morang Station, Vic. Services are rationalised, integrated into retaining wall design.
Source: COX, Copyright: Dianna Snape

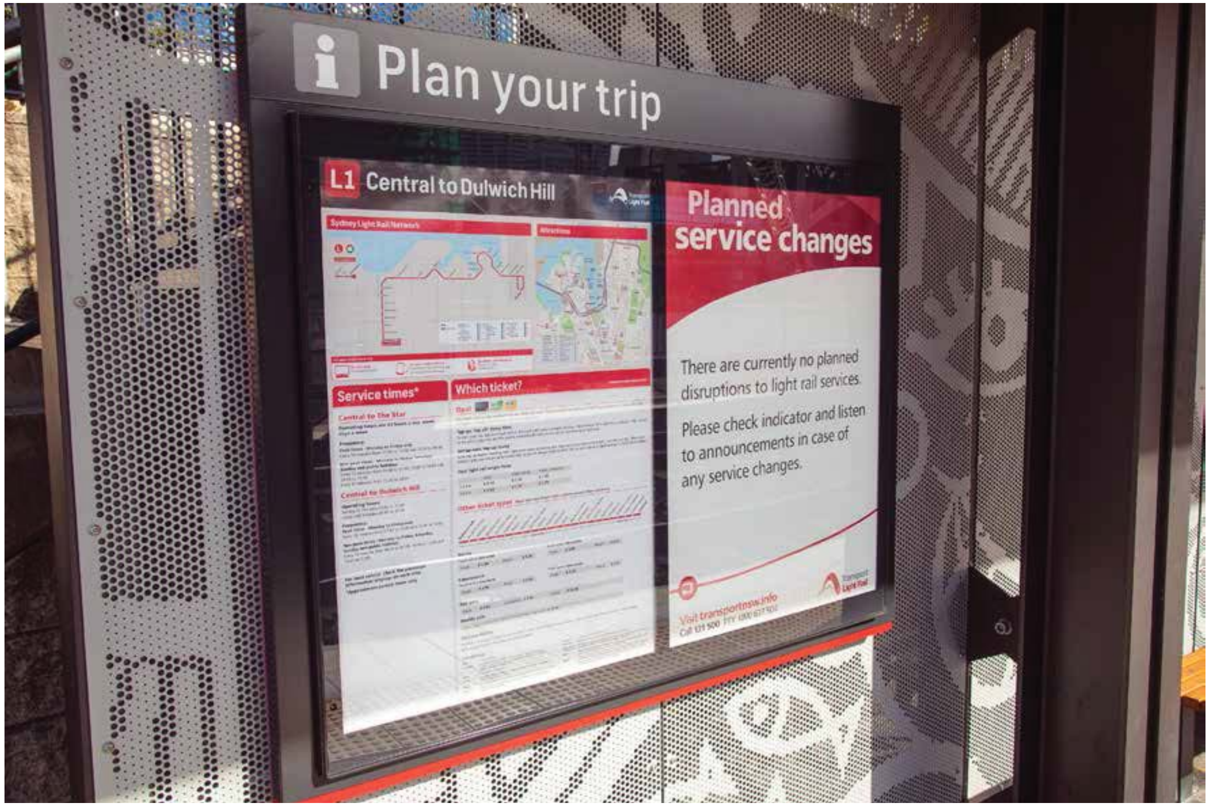
4.4 Operation and Services

The design of project infrastructure must be tailored to meet operational requirements and the transport function and integrity of the Metro system over the longer term. Design should also respond to the management and maintenance obligations that will be a critical part of the success of the Metro over successive generations as the greater Sydney region grows and demands on the transit services increase.

Stations, buildings, external areas and related corridor structures must be suitable for a high capacity passenger rail environment traversing an evolving urban setting and a complexity of interfaces. The stations need to have a consistent, reliable series of facilities that assist both staff, servicing and security operations and meet the needs of the customers who will utilise the system.

This part of the guidelines relates to the following elements:

- Information and Signage
- Advertising
- Ticketing equipment and Fixtures
- Engineering and Services Integration
- Management and Maintenance
- Security
- Emergency Requirements
- Service Vehicle Access
- Corridor Sharing
- Temporary Works



Trip Planning Information, Inner West Light Rail
Source: Courtesy of Transdev, Photographer: Scott Riley

4.4.1 Information and Signage

Relevant Design Objectives	
1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system
4	Being responsive to distinct contexts and communities

Principle

Provide intuitive, clear and consistent information and signage to enhance customer journeys through efficient navigation and interchange, creating a seamless and intuitive customer journey from origin to final destination.

Guidelines

- All customer wayfinding and information signage should:
  - Enable customers to navigate each station and precinct as part of a cohesive door-to-door journey.
  - Support customers to travel independently and successfully on the transport system.
  - Anticipate the needs of customers.
  - Provide the right information at the right time.
  - Assist to in creating predictable and intuitive environments.
  - Facilitate customer movement around stations.
  - Provide information for customers interchanging between services and modes.
  - Support customers when connecting to and from public transport by walking, cycling, catching a taxi, being dropped off, or picked up in a private vehicle, or parking in their car.
- Information is to include:
  - information for trip planning;
  - finding the right platform;
  - making connections to another form of transport;
  - destinations in the local precinct;
  - ‘real time’ information for all public transport modes;
  - wayfinding;
  - facilities and amenities.
- A modern public address system is provided that is capable of projecting clear and audible information throughout the station.
- Provide an integrated, modular signage system of attractive, robust, easily maintained materials and fixings as an enhancement of place making.
- Signage is to be located at route decision points where most needed, adopting long sightlines that enable intuitive wayfinding, reducing the need for signs.

Transport for NSW Modal Signage
Source: TfNSW

4.4.2 Advertising

Relevant Design Objectives	
1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system

Principle

Advertising is to be integrated into the station architecture or building elements, with the ability to support customer information systems and does not impact on station operations or customer experience.

Extent, type and placement of advertising should be considered in relation to station signage and passenger information.

Guidelines

- Ensure that advertising:
  - is coordinated to achieve unobstructed sightlines and legibility of the signage
  - does not conflict with customer signage or wayfinding or impede customer flows
  - is not located on stair treads or risers, seating, gateline, flooring, ceiling and in ‘slow spaces’
  - does not compromise wayfinding.
- The design and placement of customer information is prioritised as follows:
  - Wayfinding and customer information
  - Customer campaigns
  - Advertising
- The following types of advertising can be considered:
  - Digital screens
  - Digital poster cases
  - LED backlit static lightboxes
  - Technology base advertising platforms (eg beacons, wifi etc)
  - Advertising screens integrated into the passenger information screens

Digital screen advertising positioned so it does not compromise wayfinding.
Source: APN Outdoor

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4.4.3 Ticketing Equipment

Relevant Design Objectives

1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system

Principle

Provide ticketing equipment and fixtures that are integrated standard products across the Sydney Metro and Sydney Trains network and that contribute to quality and efficient service for customers.

Guidelines

General

- Common ticketing equipment and fixtures include:
  - Ticket Gates
  - Ticket Vending Machines (TVMs) and Opal Top-up Machines
- Equipment and fixtures are to be high quality, consistent throughout the Sydney Metro network and fully integrated with the station design.
- All components are to be robust and durable, suitable for the rail environment.
- Equipment and fixtures are to be located where they are visible and accessible to customers and station staff for wayfinding, security and maintenance
- Materials and installation must enable ease of access for maintenance and future repairs or replacement

Gatelines

- Gatelines are to be standard products used line-wide that contribute to quality and efficient service for customers.
- Provision should be made for accessible gates and glazed manual wide aisle gates to allow for large equipment and prams.
- The number of ticket gates provided is to be sufficient for peak periods
- Ticket gates are to be located to enable sufficient space for comfortable and safe queuing without interfering with circulation routes.
- Wide aisle gates are to be clearly visible and located on accessible paths of travel.

Ticket Vending and Top-up Machines

- Ticket vending and top-up machines are to be clustered together to provide a legible ticket sales zone within the station entrance, and designed to integrate with interior components, materials and information systems.
- Ticket vending and top-up machines are to be publicly accessible and close to the station entrance without interfering with circulation routes. Design is to provide adequate space for queuing and manoeuvring by customers using mobility aids.

Sydney Trains Opal Only Gates
Source: TfNSW

4.4.4 Engineering and Services Integration

Relevant Design Objectives

1	Ensuring an easy customer experience
2	Being part of a fully integrated transport system
4	Being responsive to distinct contexts and communities

Principle

The rail engineering and service elements for the stations and service facilities should be integrated into the design holistically, whilst being able to be easily maintained.

Guidelines

- The station structures and engineering elements are to be designed holistically, fusing architecture and engineering as one cohesive and compelling product.
- The station and station surrounds are to integrate all structural, civil, mechanical, electrical and rail systems to ensure efficient designs.
- Design integrity must be addressed through careful positioning of equipment.
- Minimise the visual impact of engineering components in public areas by concealing all services.
- Station and services design must allow for personnel access and regular maintenance of all engineering elements.
- Dedicated services zones should be integrated into the station designs allowing sufficient space proofing for future requirements.
- Location of equipment and fixings, including speakers and CCTV cameras, is to be well-considered for both public and back of house areas.
- Design is to consider the placement of access hatches in floors and ceilings away from primary customer circulation routes.

Engineered systems integrated into the platform canopy, Cheltenham Station
Source: COX

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4.4.5 Management and Maintenance

Relevant Design Objectives	
2	Being part of a fully integrated transport system

Principle

Ensure the selection of cost effective, adaptable materials and assets that are durable and easily maintained and fit-for purpose for high traffic rail environments and customer interfaces.

Guidelines

- The design for each station is to accommodate maintenance and access for all elements, including heavy and large equipment.
- Adopt a consistent and coordinated palette of materials, furniture and fixtures within stations and their precincts to promote cost effectiveness and assist in the development of an efficient management and maintenance plan for Sydney Metro.
- All signage, street furniture and operational equipment (e.g. Passenger Information Displays and CCTVs systems) in the public domain are to be designed to minimise vandalism and simplify cleaning.
- Placement and detailing of furniture, fixtures and equipment should consider impacts by birds, insects and mammals on operational assets and the customer environment.
- All assets, including paving, lighting, signage and street furniture, are to be of a standardised modular design as far as practical that is readily available and have readily replaceable components. Assets are to be robust and durable, with consideration of detailing and placement to resist vandalism.
- All components should meet the required life cycle objectives of Sydney Metro and consider sustainability objectives including dematerialisation and embodied energy.
- The design for each station is to accommodate future maintenance access to all elements, including components that may require the use of heavy or large machinery or structures to be erected for installation of structures and equipment, regular cleaning or repair.
- Stations and station precincts should be designed to facilitate access in a safe environment for operational staff and customers alike. Maintenance considerations are to be integral to the design process from an early stage.
-

Design to accommodate maintenance
Source: TfNSW

4.4.6 Security

Relevant Design Objectives

2	Being part of a fully integrated transport system

Principle

Ensure adequate security for the rail corridor infrastructure, station assets and their users. Visually integrate security elements such fencing, security screens and CCTV into the rail corridor, precinct or station design as part of a coordinated whole-of-corridor design.

Guidelines

- Risks to the rail corridor and stations must be regularly assessed during the design phase to ensure adequate control measures can be put in place.
- A public address system is to be provided at emergency egress and risk points, controllable from Station Control Rooms and Operational Control Rooms.
- CCTV must be provided throughout the station and at all egress points and risk-sensitive areas.
- CCTV cameras are to be situated where they cannot easily be evaded, damaged or obscured and must be clearly visible.
- Lighting levels are to be sufficient for adequate operation of CCTV.
- Security bollards may be provided where necessary but must not impede safe pedestrian movement. Where required, security bollards should adopt a rational layout in order to minimise visual clutter and maximise safe and accessible paths of travel.
- The visual impact of bollards should be minimised. Station precincts should, where practical, be achieved by integrating vehicle protection with street furniture or public art.
- Security fencing must be provided along the sections of the rail corridor and include permanent gated access at controlled locations. Fencing and gate locations are to be coordinated with strategic emergency access and egress points.
- Two tiers of fencing are to be utilised along the length of the rail corridor and appropriately detailed including; inner security segregation fence, outer rail corridor fence.
- Fencing throughout the station precincts and public domain areas must avoid creating dead ends or sightline conflicts.
- Passive surveillance is to be considered in the design of stations and station plazas.

Homebush, Sydney. Rail corridor security fences should be robust, easily maintained, modular systems that are readily integrated with other urban design elements such as retaining walls.
Source: COX/HASSELL

4.4.7 Emergency Requirements

Relevant Design Objectives	
2	Being part of a fully integrated transport system

Principle

Ensure that station precincts, facilities and rail corridors are provided with clearly identified zones for emergency access and egress, eliminating the potential for movement conflicts during emergencies.

Guidelines

- The precincts and rail corridor should provide access for emergency service vehicles and appropriate measures to safeguard all users.
- All station precincts and public domain areas must comply with statutory requirements and emergency procedures and relevant guidelines for fire and safety.
- Emergency requirements are to consider;
  - Effective and clearly signposted station emergency evacuation routes and assembly areas.
  - Adequate zoning and space at emergency assembly points to ensure they are free of clutter and remain accessible at all times.
  - Fire safe refuge areas with CCTV and accessible communication system in underground stations for people who are unable to self-evacuate.
  - Full integration within the relevant station and facilities evacuation plan.
  - Emergency lighting to the immediate station curtilage.
  - The appropriate location of firefighting equipment such as hydrants; all clearly identified and readily accessible.
  - The provision of emergency/security electronic help points.
- Hydrant enclosures should be easily identifiable, easily accessed modular components integrated into station cladding systems.
- Hydrant enclosures should be integrated with the surrounding wall system to minimise their visual impact.

Sydney Trains platform help point.
Source: TfNSW

4.4.8 Service Vehicle Access

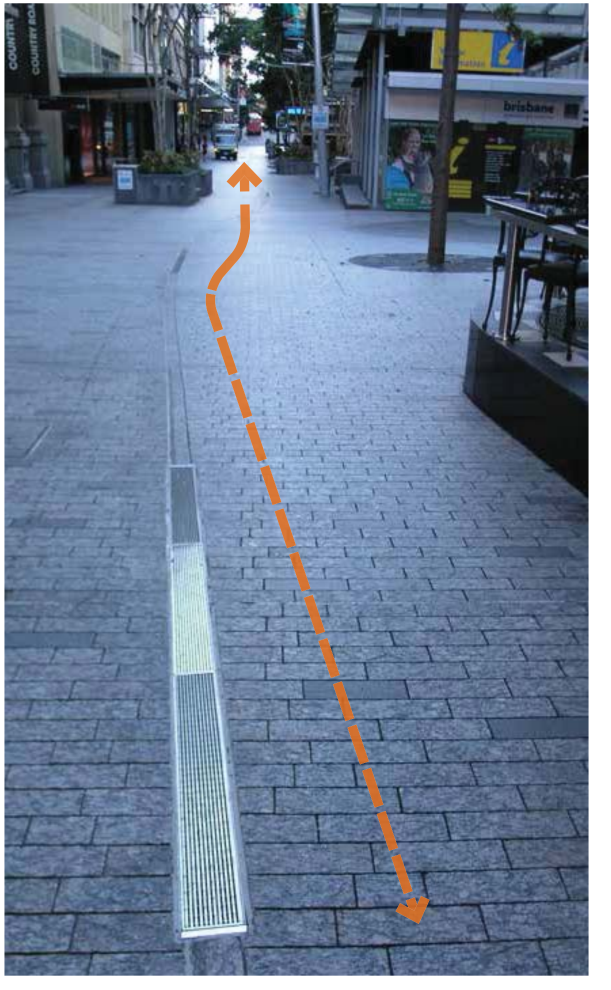
Relevant Design Objectives	
2	Being part of a fully integrated transport system
4	Being responsive to distinct contexts and communities

Principle

Ensure well defined and efficient coordination of service vehicle movements around stations.

Guidelines

- The station design is to enable access for service vehicles. Service vehicle access is not to compromise the public domain areas of the station forecourt or interchange and connectivity functions.
- Service vehicle access for all precinct functions must be addressed as part of the broader station precinct movement strategies. These strategies must address both the project works requirements and increased movements over the life of the station precincts.
- The operational function and frequency of service vehicles should be considered to determine dedicated zones for daily or frequent access, or shared zones for occasional access within station precincts. Multi-use conflicts in shared zones should be eliminated.



Queen St Mall, Brisbane. Emergency vehicle and service vehicle access through the mall has been provided.
Source: AECOM.

1 2 3 4

4.4.9 Temporary Works

Relevant Design Objectives	
2	Being part of a fully integrated transport system
4	Being responsive to distinct contexts and communities

Principle

Temporary works must minimise impacts to existing infrastructure, public domain, and structures; and ensure that means of rectification is achieved without further disturbance of surrounding areas.

Guidelines

- All temporary station access must be appropriately located within the existing streetscape and public domain to minimise disruption to general pedestrian access of the precinct.
- Hoardings must be sensitively designed and located to minimise disruption and mitigate some of the visual effects of the construction.
- Local access pathways and desire lines must be retained where feasible, with adequate way finding provided to ensure general accessibility of the precinct around the stations is retained.
- Minimise impacts to existing landscapes and trees that are to be retained.
- Explore opportunities to integrate artwork, heritage and cultural interpretation that respond to the unique character of local communities on temporary hoardings.

Artwork on hoarding
Source: ScrimWorks

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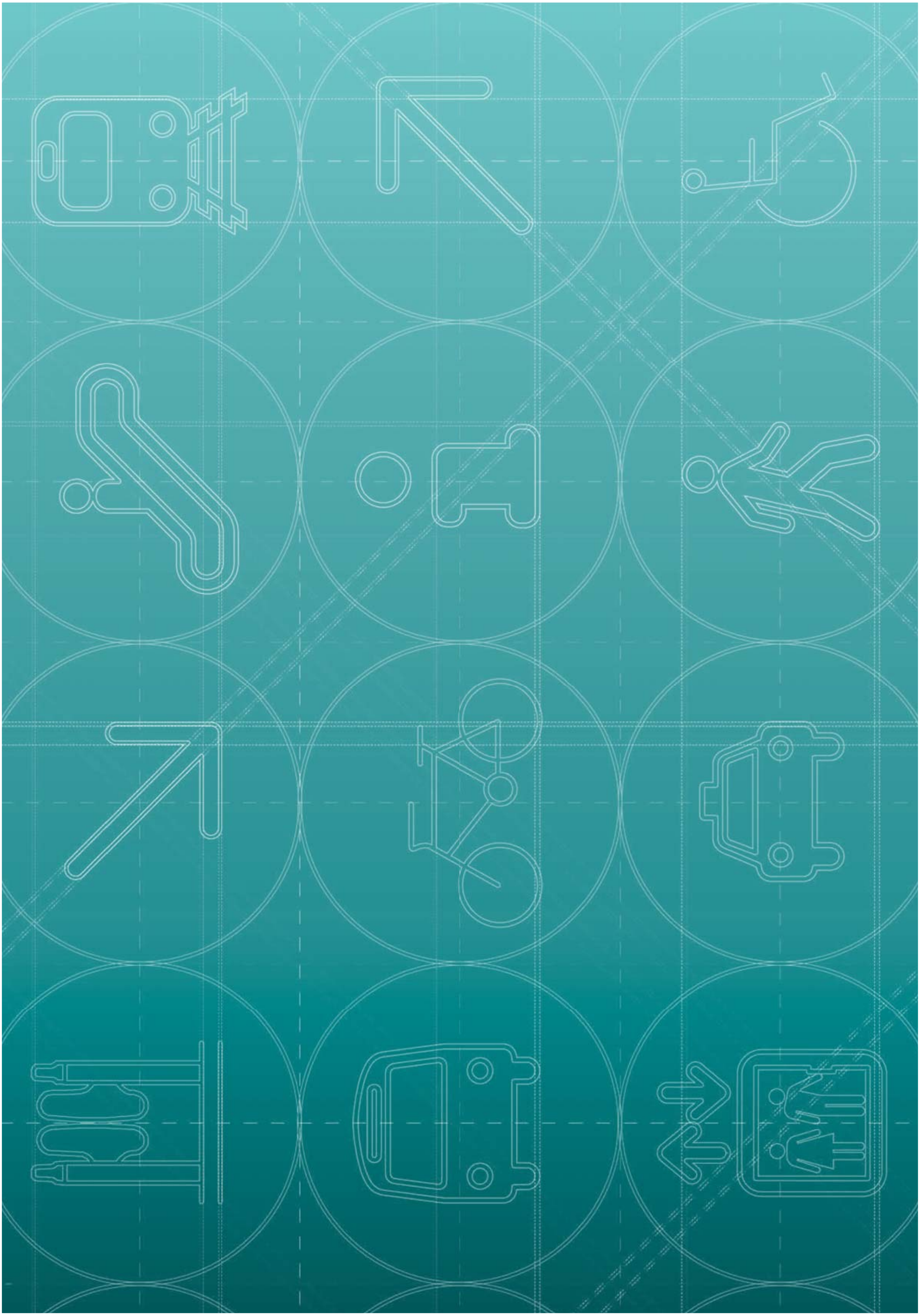

Appendix D

Construction Environmental Management Framework

sydney METRO | city & southwest

CONSTRUCTION ENVIRONMENTAL MANAGEMENT FRAMEWORK

> August 2017

NSW GOVERNMENT

Contents

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1. Introduction

1.1 Purpose and Scope

This Construction Environmental Management Framework (CEMF) is a Sydney Metro project framework which sets out the environmental, stakeholder and community management requirements for construction. It provides a linking document between the planning approval documentation and the construction environmental management documentation to be developed by the Principal Contractors relevant to their scope of works.

Sydney Metro Principal Contractors will be required to implement and adhere to the requirements of this CEMF. The requirements of this CEMF will be included as a contract document in all design and construction contracts.

1.2 Status

This is a controlled document, please refer to the version register below which is updated as required.

Version	Description	Date
1.0	For EIS 1	4 April 2012
1.1	For EIS 1 Submissions Report	26 July 2012
1.2	For EIS 2 and the Rapid Transit Rail Facility (RTRF)	31 October 2012
1.3	Updated to incorporate all planning approvals, including ECRL conversion Part 5 approvals	11 July 2014
3.0	Updated to encompass the scope of Sydney Metro – Chatswood to Sydenham EIS	16 February 2016
3.1	Updated for - Chatswood to Sydenham Submissions Report and Preferred Infrastructure Report	15 August 2016
3.2	Updated for – Sydenham to Bankstown EIS	25 August 2017

Previous versions of the CEMF (shown above) still apply to their respective works packages and form part of the contract requirements for the relevant Principal Contractors. The CEMF will continue to be updated and form part of future contract requirements for Sydney Metro works packages.

1.3 Environment and Sustainability Policy

Transport for NSW (TfNSW) has developed an Environment and Sustainability Policy (Appendix A) for the Sydney Metro Delivery Office (SMDO). Principal Contractors will be required to undertake their works in accordance with this policy. The policy reflects a commitment in the delivery of the project to:

- Align with, and support, Transport for NSW (TfNSW) Environment & Sustainability Policy.
- Optimise sustainability outcomes, transport service quality, and cost effectiveness.
- Develop effective and appropriate responses to the challenges of climate change, carbon management, resource and waste management, land use integration, customer and community expectation, and heritage and biodiversity conservation.
- Be environmentally responsible, by avoiding pollution, enhancing the natural environment and reducing the project ecological footprint, while complying with all applicable environmental laws, regulations and statutory obligations.
- Be socially responsible by delivering a workforce legacy which benefits individuals, communities, the project and industry, and is achieved through collaboration and partnerships.

1.4 Project Description

The New South Wales (NSW) Government is implementing Sydney's Rail Future, a plan to transform and modernise Sydney's rail network so that it can grow with the city's population and meet the needs of customers in the future.

Sydney Metro is a new standalone rail network identified in Sydney's Rail Future. The Sydney Metro network consists of Sydney Metro Northwest (previously known as the North West Rail Link) and Sydney Metro City & Southwest. The proposed Sydney Metro network is shown in Figure 1-1.

The proposed Sydney Metro City & Southwest (SM C&SW) comprises two core components:

- The Chatswood to Sydenham project (the project), which is the subject of this Environmental Impact Statement. The project would involve construction and operation of an underground rail line, about 15.5 kilometres long, and new stations between Chatswood and Sydenham.
- The second core component would involve upgrading the 13.5 kilometre rail line and existing stations from Sydenham to Bankstown which will be subject to a separate environmental assessment process.

Investigations have started on the possible extension of Sydney Metro from Bankstown to Liverpool. The potential extension would support growth in Sydney's south west by connecting communities, businesses, jobs and services as well as improving access between the south west and Sydney's CBD. It would also reduce growth pressure on road infrastructure and the rail network, including the potential to relieve crowding on the T1 Western Line, T2 South Line and T2 Airport Line.

The SMDO has been established as part of Transport for NSW to manage the planning, procurement and delivery of the Sydney Metro network.

Figure 1 1 The Sydney Metro network

2. Legislative and Other Requirements

The key environmental obligations to be addressed are contained within:

- Legislative requirements.
- Project approval documentation.
- Conditions of Approval.
- Environment Protection Licences.
- Other permits, approval and licences.
- Standards and guidelines.

2.1 Key Legislative Requirements

Table 1.1 below identifies key NSW environmental legislative requirements and their application to SM C&SW construction works, current as at the date of this document. TfNSW and its Contractors should regularly review their legislative requirements.

Table 1.1 NSW Legislative Requirements

Legislation and Administering Authority	Requirements	Application to Sydney Metro
Contaminated Land Management Act 1997 NSW Environment Protection Authority (EPA)	The Act provides a process for the investigation and remediation of land where contamination presents a significant risk of harm to human health or some other aspect of the environment.	TfNSW must follow the process where contaminated land is identified.
Dangerous Goods (Road and Rail Transport) Act 2008 EPA / SafeWork NSW	A licence is required for the storage (SafeWork NSW) and /or transport (EPA) of prescribed quantities of dangerous goods.	Sydney Metro Principal Contractors must obtain a licence where storage of dangerous goods would exceed licensable quantities.
Environmental Planning and Assessment Act 1979 Department of Planning and Environment (DP&E)	Encourages proper environmental impact assessment and management of development areas for the purpose of promoting the social and economic welfare of the community and a better environment.	TfNSW must adhere to mitigation measures and conditions within the planning approval documentation. The proponent and their contractors must endeavour to deliver in a consistent manner within the assessed scope of works.
Fisheries Management Act 1994 Department of Primary Industries (Fisheries)	The relevant objectives of the Act are to conserve threatened species, populations and ecological communities and promote ecologically sustainable development, including the conservation of biological diversity.	Sydney Metro projects assessed under Part 5.1 of the Environmental Planning and Assessment Act 1979 (EP&A Act) are exempt from permits required under sections 201, 205 or 219.

Legislation and Administering Authority	Requirements	Application to Sydney Metro
Heritage Act 1977 NSW Office of Environment and Heritage (OEH)	The Act aims to encourage the conservation of the State's heritage and provides for the identification and registration of items of State heritage significance.	Sydney Metro projects assessed under Part 5.1 of the Environmental Planning and Assessment Act 1979 (EP&A Act) are exempt from approvals required under Part 4 and permits required under section 139.
National Parks and Wildlife Act 1974 OEH	The objectives of the Act are for the conservation of nature and the conservation of objects, places or features (including biological diversity) of cultural value within the landscape.	Sydney Metro projects assessed under Part 5.1 of the Environmental Planning and Assessment Act 1979 (EP&A Act) are exempt from obtaining an Aboriginal Heritage Impact Permit required under section 90.
Native Vegetation Act 2003 OEH	The objective of the Act is to protect and improve the value of native vegetation.	Sydney Metro projects assessed under Part 5.1 of the Environmental Planning and Assessment Act 1979 (EP&A Act) are exempt from section 12 authorisation to clear native vegetation.
Noxious Weeds Act 1993 Department of Primary Industries	The Act aims to prevent the introduction of new weeds and restrict the spread of existing weeds.	Sydney Metro Principal Contractors must control weeds as required on land under the management of the Contractor.
Protection of the Environment Operations Act 1997 EPA	The relevant objective of the Act is to prevent environmental pollution.	Where Sydney Metro projects are scheduled activities under Schedule 1 of the Act an Environment Protection Licence (EPL) must be obtained. Further details on the requirements to obtain an EPL are provided in Section 2.3.
Roads Act 1993 Roads and Maritime Service	The relevant objective of the Act is to regulate the carrying out of various activities on public roads.	Sydney Metro Principal Contractors must obtain consent under section 138 for carrying out work in, on or over a public road, or digging up or disturbance of the surface of the road.
Waste Avoidance and Resource Recovery Act 2001 EPA	The objectives of the Act are to reduce environmental harm and provide for the reduction in waste generation.	Sydney Metro Principal Contractors must implement strategies to reduce waste volumes and report on waste generated.

Legislation and Administering Authority	Requirements	Application to Sydney Metro
Water Management Act 2000 NSW Office of Water	The relevant objective of the Act is to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality.	Sydney Metro projects assessed under Part 5.1 of the Environmental Planning and Assessment Act 1979 (EP&A Act) are exempt from obtaining water use approval under section 89, a water management work approval under section 90 or an activity approval (other than an aquifer interference approval) under section 91.

Table 1.2 identifies key Commonwealth environmental legislative requirements and their application to SM C&SW construction works, current as at the date of this document. TfNSW and its Contractors should regularly review their legislative requirements.

Table 1.2 Commonwealth Legislative Requirements

Legislation and Administering Authority	Requirements	Application to Sydney Metro
Environment Protection and Biodiversity Conservation Act 1999 Department of the Environment	The relevant objective of the Act is to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance.	A project may be defined as a controlled action under the Act due to impacts on matters of national environmental significance.
National Greenhouse and Energy Reporting Act 2007 Department of Climate Change and Energy Efficiency	The Act established a framework for reporting of greenhouse gas emissions, abatement actions, energy consumption and production data.	Sydney Metro Principal Contractors must report on greenhouse gas and energy usage data as required by the Act.

2.2 Environmental Approvals

Sydney Metro Northwest is classified as Critical State Significant Infrastructure and was approved under the following in accordance with Section 115W of the Environmental Protection and Assessment Act 1997:

- Staged State Infrastructure Approval (1 October 2011, modified on 25 September 2012)
- Stage 1 – Major Civil Construction Works (25 September 2012, modified on 18 April 2013)
- Stage 2 – Stations, Rail Infrastructure and Systems (8 May 2013, modified on 20 May 2014).

Some components of Sydney Metro Northwest (such as the conversion of the Epping to Chatswood component of the project) have also been approved under Part 5 of the Environmental Protection and Assessment Act. in which case TfNSW is the consent authority.

Sydney Metro City and Southwest is also classified as Critical State Significant Infrastructure and requires approval from a consent authority under the requirements of the Environmental Protection and Assessment Act 1997 (Section 115W).

Two separate approvals are sought:

- Sydney Metro City and Southwest – Chatswood to Sydenham (Approved January 2017)
- Sydney Metro City and Southwest - Sydenham to Bankstown

The requirements of the approval are required to be complied with by TfNSW. Responsibility for implementing mitigation measures and conditions of approval will be allocated between TfNSW and Principal Contractors as appropriate. Typically TfNSW will produce a Staging Report which sets out the applicability and allocation of approval requirements within the project's program of works.

2.3 Environment Protection Licence Requirements

Sydney Metro projects often meet the definition of a number of scheduled activities under Schedule 1 of the *Protection of the Environmental Operation Act 1997* (POEO Act) and as such our contractors may be required to obtain an Environment Protection Licence (EPL) or work under the existing EPL held by Sydney Trains.

Where required, Sydney Metro Principal Contractors will:

a. Apply for and be granted an EPL from the EPA.

b. Hold an EPL which covers their scope of works as necessary under the POEO Act.

c. Undertake their scope of works in accordance with the conditions of the applicable EPLs as issued by the EPA.

d. Work under the existing Sydney Trains EPL.

2.4 Standards and Guidelines

Numerous environmental publications, standards, codes of practice and guidelines are relevant to TfNSW construction and are referenced throughout this Construction Environmental Management Framework. A summary of these applicable standards and guidelines is provided in Table 1.3.

Table 1.3 Environmental Standards and Guidelines

Standard / Guideline	Relevant Authority	CEMF Reference
ISO14001 Environmental Management System – Requirements with Guidelines for Use	DP&E	Section 3.1
Interim Construction Noise Guidelines (Department of Environment and Climate Change, 2009)	EPA	Section 9.2
Managing Urban Stormwater: Soil and Construction (Landcom, 2008)	EPA	Section 15.2
AS4282:1997 Control of the Obtrusive Effect of Outdoor Lighting	OEH	Section 12.2
Waste Classification Guidelines (Department of Environment, Climate Change and Water, 2008)	EPA	Section 17.2
AS 1742.3 Manual of uniform traffic control devices Part 3: Traffic control for works on roads	RMS	Section 8.2
RMS Traffic Control at Worksites Manual	RMS	Section 8.2
Australian and New Zealand Guidelines for Fresh and Marine Water Quality	ANZECC	Section 15.2

3. Environmental Management Requirements

3.1 Environmental and Sustainability Management System

a. Principal Contractors are required to have a corporate Environmental Management System certified under AS/NZS ISO 14001:2004 and to have transitioned this accreditation into AS/NZS ISO 14001:2015 by September 2018.

b. Principal Contractors are required to develop a project based Environment and Sustainability Management System (E&SMS). The E&SMS will:

   i. Be consistent with the Principal Contractors corporate Environmental Management System and AS/NZS ISO 14001:2004 or 2015;

   ii. Be supported by a process for identifying and responding to changing legislative or other requirements;

   iii. Include processes for assessing design or construction methodology changes for consistency against the planning approvals;

   iv. Include processes for tracking and reporting performance against sustainability and compliance targets;

   v. Include a procedure for the identification and management of project specific environmental risks and appropriate control measures; and

   vi. Be consistent with the SM C&SW Sustainability Strategy and Sydney Metro Environment and Sustainability Policy.

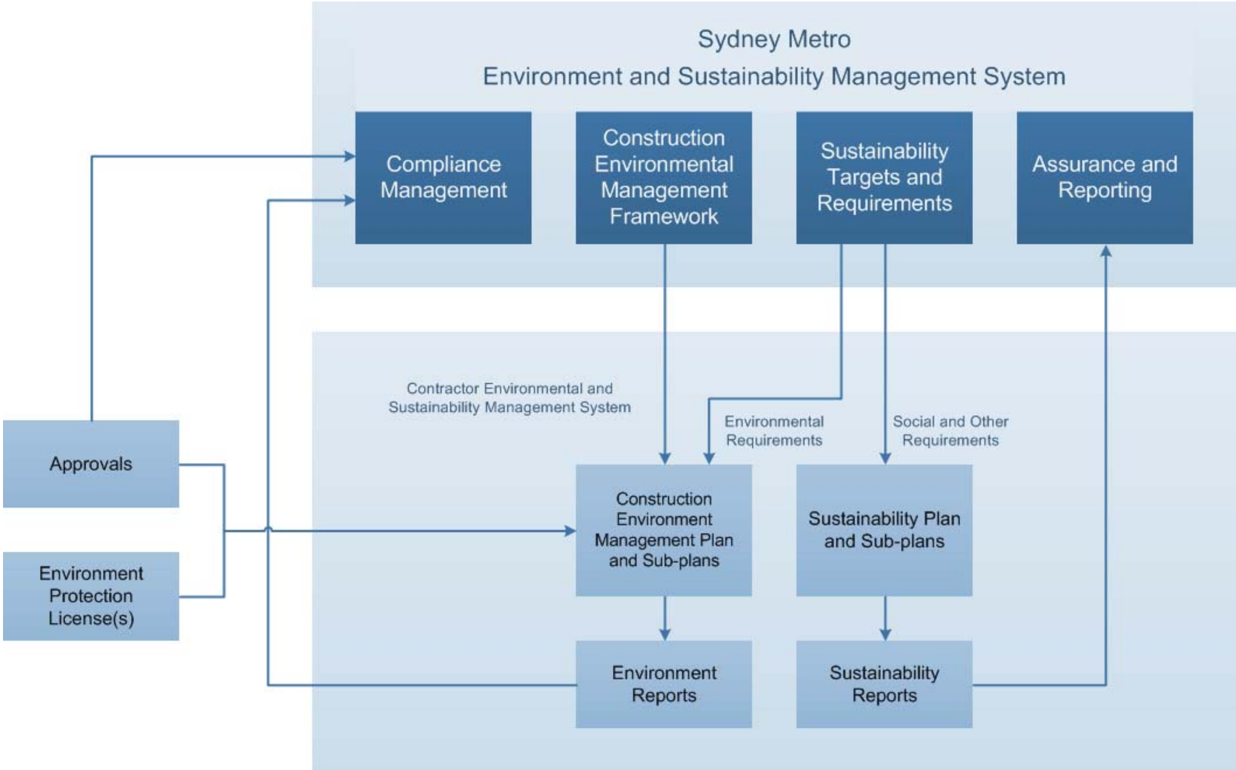
c. All sub-contractors engaged by the Principal Contractor will be required to work under the Principal Contractor's E&SMS.

d. The relationship between key documents within the Sydney Metro Environment and Sustainability Management System and the Principal Contractor's Environment and Sustainability Management System is shown in Figure 2.

e. The Principal Contractors Sustainability Plan and its sub plans will capture governance and design requirements as well as social sustainability initiatives as required by the Sydney Metro Sustainability Strategies.

f. These plans vary in scope across different delivery packages.

Figure 2 - Environmental Management and Sustainability Structure



3.2 Construction Sustainability Management Plan

a. Principal Contractors are required to prepare and implement a Sustainability Management Plan (SMP) relevant to the scale and nature of their scope of works. The SMP shall comprise of a main SMP document and issue-specific sub-plans.

b. Depending on the scope and scale of the works, TfNSW may decide to streamline the SMP and sub-plan requirements. As a minimum the SMP will address and detail:

i. The requirements of the relevant planning approval documentation, any relevant conditions of all other permits and licences, the Contractor's corporate EMS, the sustainability provisions of the contract documentation, and this Construction Environmental Management Framework;

ii. The sustainability management team structure, including key personnel authority and roles of key personnel, lines of responsibility and communication, minimum skill levels of each role and interfaces with the overall project organisation structure;

iii. A sustainability policy statement and strategies for adaptation to climate change, resource management (including energy, water and waste), workforce development, procurement and biodiversity enhancement;

iv. Sustainability initiatives to be implemented during the project;

v. How sustainability initiatives will be identified and implemented;

vi. The processes and methodologies for assurance, monitoring, auditing, corrective action, continuous improvement and reporting on sustainability performance;

vii. The processes and methodologies which will be used to achieve the required scores under rating systems identified in contract documents;

viii. The processes and procedures for undertaking climate change risk assessments;

ix. The processes and procedures for the identification and implementation of climate change adaption measures;

x. The approach to sustainable procurement including:

- The processes and procedures that will be used to provide environmental and social improvement;
- The processes and environmental and social criteria that will be used for the selection of Subcontractors;
- The processes that will be used to ensure ethical sourcing of labour and materials;
- Where equipment, materials or labour are procured from locations outside Australia, the processes that will be used to ensure human rights impacts and risks are identified and mitigated; and
- Interfaces with other Project Plans.

c. Depending on the scope of the works, the SMP will also include, as a separate sub-plans:

i. A Construction Workforce Development Plan;

ii. A Construction Carbon and Energy Management Plan;

iii. A Materials Management Plan; and

iv. A Waste Management & Recycling Plan.

d. The Workforce Development Plan will address and detail:

i. The proposed response to workforce-related regulatory, planning approval, and contract requirements which will be addressed for the project;

ii. The workforce development team structure, including key personnel authority and roles of key personnel, lines of responsibility and communication, minimum skill levels of each role and interfaces with the overall project organisation structure;

iii. A description of the workforce development initiatives which will be implemented, and the implementation methodology, including for:

- Assessing current and future workforce skill needs and workforce profiles including a skills and workforce gap plan;
- Increasing local employment, local business opportunities and involvement of local SMEs;
- Provision of relevant Nationally Recognised Accredited Training;
- Increasing workforce diversity and inclusion, targeting indigenous workers and businesses, female representation in non-traditional trades and long-term unemployed;
- Participation in work placement and education programs for young people; and
- Increasing participation of apprentices and trainees.

iv. The processes and methodologies for assurance, monitoring, auditing, corrective action, continuous improvement and reporting on workforce development performance.

3.3 Construction Environmental Management Plan

a. Principal Contractors are required to prepare and implement a Construction Environmental Management Plan (CEMP) relevant to the scale and nature of their scope of works. The CEMP shall comprise of a main CEMP document, issue specific sub plans, activity specific procedures and site based control maps. The CEMP shall illustrate the relationship between other plans required by the contract, in particular those that relate to design management.

b. Depending on the scope and scale of the works, TfNSW may decide to streamline the CEMP and sub-plan requirements. For example, depending on the risk associated with particular environmental issues it may be appropriate to remove the need for a sub plan, or replace with a procedure as part of the CEMP.

c. The CEMP will cover the requirements of the relevant planning approval documentation, the conditions of all other permits and licences, the Principal Contractor's corporate EMS, the environmental provisions of the contract documentation and this Construction Environmental Management Framework.

d. As a minimum the CEMP will:

   i. Include a contract specific environmental policy;

   ii. Include a description of activities to be undertaken during construction;

   iii. For each plan under the CEMP include a matrix of the relevant Conditions of Approval or Consent referencing where each requirement is addressed;

   iv. For each plan under the CEMP, set objectives and targets, and identify measurable key performance indicators in relation to these;

   v. For each role that has environmental accountabilities or responsibilities, including key personnel, provide a tabulated description of the authority and roles of key personnel, lines of responsibility and communication, minimum skill level requirements and their interface with the overall project organisation structure;

   vi. Assign the responsibility for the implementation of the CEMP to the Environment Manager, who will have appropriate experience. The Principal Contractor's Project Director will be accountable for the implementation of the CEMP;

   vii. Identify communication requirements, including liaison with stakeholders and the community;

   viii. Include induction and training requirements and a summary of the Training Needs Analysis required in Section 3.9(b);

   ix. Management strategies for environmental compliance and review of the performance of environmental controls;

   x. Processes and methodologies for surveillance and monitoring, auditing and review, and reporting on environmental performance including environmental compliance tracking;

   xi. Include procedures for emergency and incident management, non-compliance management, and corrective and preventative action; and

   xii. Include procedures for the control of environmental records.

e. The CEMP and associated sub-plans will be reviewed by TfNSW and/or an independent environmental representative (see Section 3.11) prior to any construction works commencing. Depending on the Conditions of Approval, the CEMP and certain sub-plans may also require the approval of the Department of Planning and Environment (DP&E).

f. Where a corresponding systems document exists within the Sydney Metro Integrated Management System, the Principal Contractor's procedures will be required to be consistent with any requirements in those documents.

3.4 Construction Environmental Management Sub-Plans

a. Subject to Section 3.3(b) and Section 3.2(b) the Principal Contractor will prepare issue-specific environmental sub plans to the CEMP and SMP which address each of the relevant environmental impacts at a particular site or stage of the project. Issue specific sub plans will include:

   i. Spoil management;
   ii. Groundwater management;
   iii. Traffic and transport management;
   iv. Noise and vibration management;
   v. Heritage management;
   vi. Flora and fauna management;
   vii. Visual amenity management;
   viii. Carbon and energy management;
   ix. Materials management;
   x. Soil and water management;
   xi. Air quality management; and
   xii. Waste management and recycling.

b. Additional detail on the minimum requirements for these sub plans is provided in Sections 6-17 of this CEMF.

3.5 Environmental Procedures and Control Maps

a. The Principal Contractor will prepare and implement activity specific environmental procedures. These procedures should supplement environmental management sub plans, but may substitute for sub plans in agreement with TfNSW if a reasonable risk based justification can be made and the sub plan is not a requirement of any approval.

b. The procedures will include:

   i. A breakdown of the work tasks relevant to the specific activity and indicate responsibility for each task;
   ii. Potential impacts associated with each task;
   iii. A risk rating for each of the identified potential impacts;
   iv. Mitigation measures relevant to each of the work tasks; and
   v. Responsibility to ensure the implementation of the mitigation measures.

c. The Principal Contractor will prepare and implement site based progressive Environmental Control Maps (ECM's) which as a minimum:

   i. Is a progressive document depicting a current representation of the site;
   ii. Indicates which environmental procedures, environmental approvals, or licences are applicable;

iii. Illustrates the site showing significant structures, work areas and boundaries;

iv. Illustrates environmental control measures and environmentally sensitive receivers;

v. Is endorsed by the Principal Contractors Environmental Manager or delegate; and

vi. Relevant workers will be trained in the requirements of and will sign off the procedures prior to commencing works on the specific site and / or activity.

3.6 Additional Environmental Assessments

a. Where the requirement for an additional environmental assessment is identified, this will be undertaken prior to undertaking any physical works. The environmental assessment will include:

   i. A description of the existing surrounding environment;

   ii. Details of the ancillary works and construction activities required to be carried out including the hours of works;

   iii. An assessment of the environmental impacts of the works, including, but not necessarily limited to, traffic, noise and vibration, air quality, soil and water, ecology and heritage;

   iv. Details of mitigation measures and monitoring specific to the works that would be implemented to minimise environmental impacts; and

   v. Identification of the timing for completion of the construction works, and how the sites would be reinstated (including any necessary rehabilitation).

3.7 Condition Surveys

a. Prior to the commencement of construction the Principal Contractors will offer Pre-construction Building Condition Surveys, in writing, to the owners of buildings where there is a potential for construction activities to cause cosmetic or structural damage. If accepted, the Principal Contractor will produce a comprehensive written and photographic condition report produced by an appropriate professional prior to relevant works commencing.

b. Prior to the commencement of construction the Principal Contractor will prepare a Road Dilapidation Report for all local public roads proposed to be used by heavy vehicles.

3.8 Register of Hold Points

a. Principal Contractors will identify hold points, beyond which approval is required to proceed with a certain activity. Example activities include vegetation removal and water discharge. Hold points will be documented in relevant CEMPs.

b. Table 1.4 provides the structure for the register of hold points as well as a preliminary list of hold points which will be implemented.

Table 1.4 Preliminary Register of Hold Points

Hold Point	Release of Hold Point	By Who
Prior to Vegetation Clearing / Ground Disturbance	Pre-clearing inspection Erosion and sediment control plan	Qualified Ecologist Contractor's Environmental Manager or delegate
Discharge of water	Water tested to verify compliance and approval to discharge	Contractor's Environment Manager or delegate
Out of hours works	Noise Assessment	Contractor's Environment Manager
Use of local roads by heavy vehicles	Road Dilapidation Report	Appropriate Professional nominated by Principal Contractor
Construction identified as affecting buildings	Building Condition Survey	Appropriate Professional nominated by Principal Contractor

3.9 Training, Awareness and Competence

a. Principal Contractors will be responsible for determining the training needs of their personnel. As a minimum this will include site induction, regular toolbox talks and topic specific environmental training as follows:

i. The site induction will be provided to all site personnel and will include, as a minimum:
- Training purpose, objectives and key issues;
- Contractor's environmental policy and key performance indicators;
- Due diligence, duty of care and responsibilities;
- Relevant conditions of any environmental licence and/or the relevant conditions of approval;
- Site specific issues and controls including those described in the environmental procedures;
- Reporting procedure for environmental hazards and incidents; and
- Communication protocols.

ii. Toolbox talks will be held on a regular basis in order to provide a project or site wide update, including any key or recurring environmental issues; and

iii. Topic specific environmental training should be based upon, but is not limited to, Issue specific sub-plans required under Section 3.4 (a) (i-xi).

b. Principal Contractors will conduct a Training Needs Analysis which:

i. Identifies that all staff are to receive an environmental induction and undertake environmental incident management training;

ii. Identifies the competency requirements of staff that hold environmental roles and responsibilities documented within the Construction Environmental Management Plan and sub-plans;

iii. Identifies appropriate training courses/events and the frequency of training to achieve and/or maintain these competency requirements; and

iv. Implements and documents as part of the CEMP a training schedule that plans attendance at environmental training events, provides mechanisms to notify staff of their training requirements, and identifies staff who do not attend scheduled training events or who have overdue training requirements.

3.10 Emergency and Incident Response

a. Principal Contractors will develop and implement a Pollution Incident Response Management Plan, in accordance with the requirements of the POEO Act. Contractors' emergency and incident response procedures will also be consistent with any relevant SMDO procedures and will include:

i. Categories for environmental emergencies and incidents;

ii. Notification protocols for each category of environmental emergency or incident, including notification of TfNSW and notification to owners / occupiers in the vicinity of the incident. This is to include relevant contact details;

iii. Identification of personnel who have the authority to take immediate action to shut down any activity, or to affect any environmental control measure (including as directed by an authorised officer of the EPA);

iv. A process for undertaking appropriate levels of investigation for all incidents and the identification, implementation and assessment of corrective and preventative actions; and

v. Notification protocols of incidents to the EPA, DP&E or OEH that are made by the Contractor or TfNSW.

b. The Contractor will make all personnel aware of the plan and their responsibilities.

3.11 Independent Environmental Representatives

a. TfNSW will engage Independent Environmental Representatives (ERs) to undertake the following, along with any additional roles as required:

i. Review, provide comment on and endorse (where required) any relevant environmental documentation to verify it is prepared in accordance with relevant environmental legislation, planning approval conditions, Environment Protection Licences, relevant standards and this CEMF;

ii. Monitor and report on the implementation and performance of the above mentioned documentation and other relevant documentation;

iii. Provide independent guidance and advice to TfNSW and the Contractors in relation to environmental compliance issues and the interpretation of planning approval conditions;

iv. Be the principal point of advice for the DP&E in relation to all questions and complaints concerning the environmental performance of the project;

v. Ensure that environmental auditing is undertaken in accordance with all relevant project requirements; and

vi. Recommend reasonable steps, including 'stop works', to be taken to avoid or minimise adverse environmental impacts.

3.12 Roles and Responsibilities

a. In relation to Roles and Responsibilities the CEMP will:

   i. Describe the relationship between the Principal Contractor, TfNSW, key regulatory stakeholders, the independent environmental representative and the independent certifier;

   ii. For each role that has environmental accountabilities or responsibilities, including key personnel, provide a tabulated description of the authority and roles of key personnel, lines of responsibility and communication, minimum skill level requirements and their interface with the overall project organisation structure;

   iii. Provide details of each specialist environment, sustainability or planning consultant who is employed by the Principal Contractor including the scope of their work; and

   iv. Provide an overview of the role and responsibilities of the Independent Environmental Representative, the Independent Certifier and other regulatory stakeholders.

b. All sub-contractors engaged by the Principal Contractor will be required to operate within the EMS documentation of that Principal Contractor.

3.13 Environmental Monitoring, Inspections and Auditing

a. Issue specific environmental monitoring will be undertaken as required or as additionally required by any approval, permit or licence conditions.

b. The results of any monitoring undertaken as a requirement of the EPL will be published on the Principal Contractor's, or a project specific, website within 14 days of obtaining the results.

c. Environmental inspections will include:

   i. Surveillance of environmental mitigation measures by the Site Foreman; and

   ii. Periodic inspections by the Principal Contractor's Environmental Manager (or delegate) to verify the adequacy of all environmental mitigation measures. This will be documented in a formal inspection record.

d. Regular site inspections by the ERs and TfNSW representatives at a frequency to be agreed with the Principal Contractor.

e. Principal Contractors must undertake internal environmental audits. The scope will include:

   i. Compliance with any approval, permit or licence conditions;

   ii. Compliance with the E&SMS, CEMP, SMP, sub-plans and procedures;

   iii. Community consultation and complaint response;

   iv. Environmental training records; and

   v. Environmental monitoring and inspection results.

f. TfNSW (or an independent environmental auditor) will also undertake periodic audits of the Principal Contractor's E&SMS and compliance with the environmental aspects of contract documentation, including this Construction Environmental Management Framework.

3.14 Environmental Non-compliances

a. Principal Contractors will document and detail any non-compliances arising out of the above monitoring, inspections and audits. TfNSW will be made aware of all non-compliances in a timely manner.

b. Principal Contractors will develop and implement corrective actions to rectify the non-compliances and preventative actions in order to prevent a re-occurrence of the non-compliance. Contractors will also maintain a register of non compliances, corrective actions and preventative actions.

c. TfNSW or the Environmental Representative may raise non-compliances against environmental requirements.

3.15 Environmental Records and Compliance Reporting

a. Principal Contractors will maintain appropriate records of the following:

   i. Site inspections, audits, monitoring, reviews or remedial actions;

   ii. Documentation as required by performance conditions, approvals, licences and legislation;

   iii. Modifications to site environmental documentation (eg CEMP, sub-plans and procedures); and

   iv. Other records as required by this Construction Environmental Management Framework.

b. Records will be retained onsite for the duration of works.

c. Additionally records will be retained by the Principal Contractor for a period of no less than 7 years. Records will be made available in a timely manner to TfNSW (or their representative) upon request.

d. Compliance reports detailing the outcome of any environmental surveillance activity including internal and external audits (refer to Section 3.13) will be produced by the Principal Contractors Environmental Manager or delegate. These reports will be submitted to TfNSW at an agreed frequency.

3.16 Review and Improvement of the E&SMS

a. Principal Contractors will ensure the continual review and improvement of the E&SMS. This will generally occur in response to:

   i. Issues raised during environmental surveillance and monitoring;

   ii. Expanded scope of works;

   iii. Environmental incidents; and

   iv. Environmental non-conformances.

b. A formal review of the E&SMS by the Principal Contractor's Senior Management Team will also occur on an annual basis, as a minimum. This review shall generate actions for the continual improvement of the E&SMS and supporting management plans.

4. Stakeholder and Community Involvement

4.1 Overview

a. Throughout construction, Sydney Metro and the Principal Contractors will work closely with stakeholders and the community to ensure they are well informed regarding the construction works.

b. Stakeholders and the community will be informed of significant events or changes that affect or may affect individual properties, residences and businesses. These will include:

   i. Significant milestones;

   ii. Design changes;

   iii. Changes to traffic conditions and access arrangements for road users and the affected public; and

   iv. Construction operations which will have a direct impact on stakeholders and the community including noisy works, interruptions to utility services or construction work outside of normal work hours.

4.2 Community Communication Strategy

a. A Community Communication Strategy will be developed by each Sydney Metro Principal Contractor.

b. Key elements of the Community Communication Strategy, which will be implemented at appropriate times in the construction process, will include:

   i. Notification (including targeted letterbox drops and email) of any works that may disturb local residents and businesses (such as noisy activities and night works) at least seven days prior to those works commencing;

   ii. Notification (including targeted letterbox drops and email) of works that may affect transport (such as road closures, changes to pedestrian routes and changes to bus stops);

   iii. Traffic alerts (via email) to all key traffic and transport stakeholders advising of any changes to access and local traffic arrangements (at least seven days prior to significant events);

   iv. Print and radio advertisements regarding major traffic changes;

   v. 24-hour toll-free community project information phone line;

   vi. Complaints management process;

   vii. Community information sessions, as required;

   viii. Regular updates to the Sydney Metro website (sydneymetro.info), including uploading of all relevant documents, and contact details for the stakeholder and community relations team;

   ix. Provision of information to the Sydney Metro Community Information Centre including community newsletters, information brochures and fact sheets and interactive web-based activities;

   x. Clear signage at the construction sites;

   xi. Regular newspaper advertisements in local and metropolitan papers;

   xii. Regular inter-agency group meetings;

   xiii. Community, business and stakeholder satisfaction surveys and feedback forms;

   xiv. Translator and interpreter services; and

xv. The Principal Contractor's Community Relations Team will liaise with the Sydney Metro Project Communications team as the point of contact for the community.

4.3 Complaint Handling

a. Community liaison and complaints handling will be undertaken in accordance with the Construction Complaints Management System and will include:

   i. Principal Contractors will deal with complaints in a responsive manner so that stakeholders' concerns are managed effectively and promptly; and

   ii. A verbal response will be provided to the complainant as soon as possible and within a maximum of two hours from the time of the complaint (unless the complainant requests otherwise). A detailed written response will then be provided, if required, to the complainant within one week.

4.4 Urban Design of Temporary Works

a. Principal Contractors will ensure as a minimum:

   i. Temporary construction works consider urban design and visual impacts, including:

      - Artwork, graphics and images to enhance the visual appearance of temporary works in high visibility locations;
      - Project information to raise awareness on benefits, explain the proposed works at each site and provide updates on construction progress;
      - Community information, including contact numbers for enquiries / complaints;
      - Signage and information to mitigate impacts on local businesses which may be obscured by the construction site;
      - Sydney Metro advertising / public awareness campaigns; and
      - Logos / branding, including Sydney Metro, NSW Government, and Contractor branding.

   ii. The design of all temporary works will require TfNSW approval in relation to urban design and visual impacts and TfNSW will stipulate the design of hording artwork, including:

      - Sydney Metro advertising / public awareness campaigns; and
      - Logos / branding, including Sydney Metro, NSW Government, and Contractor branding.

b. Construction hoardings, scaffolding and acoustic sheds will be regularly inspected and kept clean and free of dust build up. Graffiti on construction hoardings, scaffolding or acoustic sheds will be removed or painted over promptly.

c. The principles of Crime Prevention Through Environmental Design will be applied to all works, including temporary works, that have a public interface.

4.5 Business and Property Impacts

a. Principal Contractors will proactively work with potentially affected stakeholders to identify the likely impacts and put in place measures to minimise impacts.

b. Construction works will be undertaken to meet the following objectives:

   i. Minimise the potential impact of the project to businesses affected by construction works;

   ii. Ensure businesses are kept informed of the project and consulted in advance of major works or factors that are likely to have a direct impact;

   iii. Consult with all business directly affected by changes to access arrangements regarding specific requirements at least two weeks prior to those changes coming into effect; and

   iv. Ensure that business stakeholder enquiries and complaints regarding the project are managed and resolved effectively.

c. Principal Contractors will document in the Community Communication Strategy (Section 4.2) key issues relating to business impacts by locality with a particular focus on proactive consultation with affected businesses. Including:

   i. Identification of specific businesses which are sensitive to construction activity disturbances;

   ii. Summary of the commercial character of the locality, its general trading profile (daily and annually) and information gained from the business profiling such as:

      - Operating hours;
      - Main delivery times;
      - Reliance on foot traffic;
      - Any signage or advertising that may be impacted;
      - Customer origin; and
      - Other information specific to the business that will need to be considered in construction planning.

   iii. Define the roles and responsibilities in relation to the control and monitoring of business disturbances;

   iv. Identification of locality specific standard business mitigation measures which would be implemented;

   v. Maps and diagrams to illustrate the information for easy identification of measures which would be implemented;

   vi. Description of the monitoring, auditing and reporting procedures;

   vii. Procedure for reviewing performance and implementing corrective actions;

   viii. Description of the complaints handling process; and

   ix. Procedure for community consultation and liaison.

5. General Site Works

Figure 3 - Aerial View of the Sydney Metro Norwest Station Site

5.1 Working Hours

a. Standard working hours are between 7am – 6pm on weekdays and 8am – 1pm on Saturdays.

b. Works which can be undertaken outside of standard construction hours without any further approval include:

   i. Those which have been described in respective environmental assessments as being required to take place 24/7. For example, tunnelling and underground excavations and supporting activities will be required 24/7;

   ii. Works which are determined to comply with the relevant Noise Management Level at sensitive receivers;

   iii. The delivery of materials outside of approved hours as required by the Police or other authorities (including RMS) for safety reasons;

   iv. Where it is required to avoid the loss of lives, property and / or to prevent environmental harm in an emergency; and

   v. Where written agreement is reached with all affected receivers.

c. Principal Contractors may apply for EPA approval to undertake works outside of normal working hours under their respective Environment Protection Licences.

5.2 Site Layout

a. Principal Contractors will consider the following in the layout of construction sites:

   i. The location of noise intensive works and 24 hour activities in relation to noise sensitive receivers;

   ii. The location of site access and egress points in relation to noise and light sensitive receivers, especially for sites proposed to be utilised 24 hours per day;

   iii. The use of site buildings to shield noisy activities from receivers;

   iv. The use of noise barriers and / or acoustic sheds where feasible and reasonable for sites proposed to be regularly used outside of daytime hours; and

   v. Aim to minimise the requirement for reversing, especially of heavy vehicles.

5.3 Reinstatement

a. Mitigation measures for reinstatement will be produced in consultation with TfNSW, the community and stakeholders.

b. Mitigation measures required for reinstatement will be incorporated into the CEMP and will include as a minimum:

   i. Principal Contractors will clear and clean all working areas and accesses at project completion;

   ii. At the completion of construction all plant, temporary buildings or vehicles not required for the subsequent stage of construction will be removed from the site;

   iii. All land, including roadways, footpaths, loading facilities or other land having been occupied temporarily will be returned to their pre-existing condition or better; and

   iv. Reinstatement of community spaces, infrastructure and services will occur as soon as possible after completion of construction.

6. Spoil Management

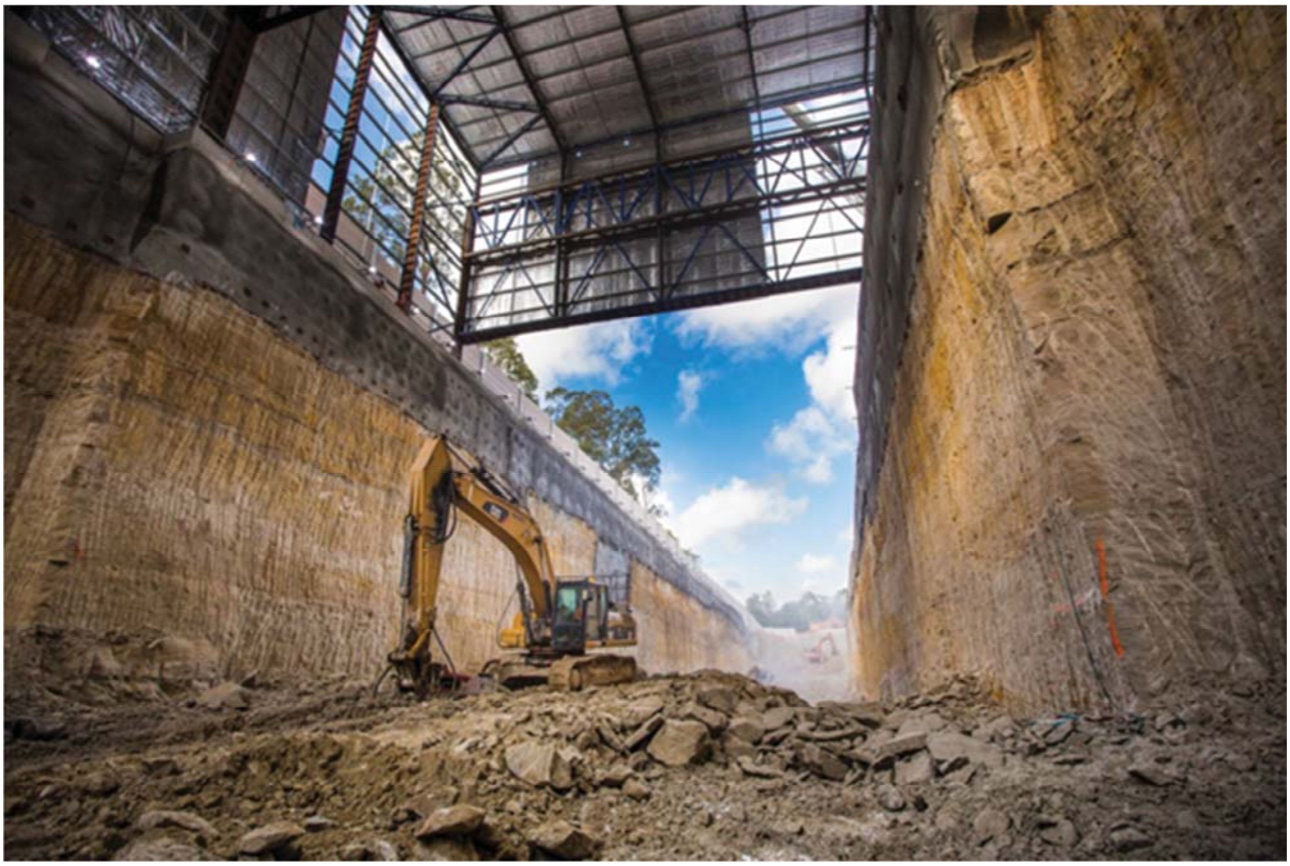


Figure 4 - Spoil and Excavation Works at the Showground Station Site

6.1 Spoil Management Objectives

a. The following spoil management objectives will apply to the construction of the project:

i. Minimise spoil generation where possible;

ii. The project will mandate 100% reuse or recycling (on or off-site) of usable spoil;

iii. Spoil will be managed with consideration to minimising adverse traffic and transport related issues;

iv. Spoil will be managed to avoid contamination of land or water;

v. Spoil will be managed with consideration of the impacts on residents and other sensitive receivers; and

vi. Site contamination will be effectively managed to limit the potential risk to human health and the environment.

6.2 Spoil Management Implementation

a. Principal Contractors will develop and implement a Spoil Management Plan for their scope of works. The Spoil Management Plan will include as a minimum:

i. The spoil mitigation measures as detailed in the environmental approval documentation;

ii. The responsibilities of key project personnel with respect to the implementation of the plan;

iii. Procedures and methodologies for the haulage and disposal locations, storage and stockpiling arrangements, including those for virgin excavated natural material, contaminated and unsuitable material;

iv. Procedures for the testing, excavation, classification, handling and reuse of spoil;

v. measures that will be implemented to both reduce spoil quantities and maximise the beneficial reuse of spoil which will be generated during the performance of the TSE Contractor's Activities, including how spoil generation is minimised through the design development process;

vi. Details, links or references to where traffic movements in relation to spoil are described, and measures that will be implemented to minimise traffic and noise impacts associated with haulage and disposal of spoil;

vii. quantities for reuse of spoil within the Construction Site, for beneficial reuse of spoil off site and for spoil disposal;

viii. Processes and procedures for the management of the environmental and social impacts of spoil transfer and reuse;

ix. A register of spoil receipt sites that includes the site or project name, location, capacity, site owner and which tier the site is classified as under the spoil reuse hierarchy;

x. Spoil management monitoring requirements; and

xi. Compliance record generation and management.

b. Spoil management measures will be included in regular inspections undertaken by the Contractor, and compliance records will be retained. These will include:

i. Records detailing the beneficial re-use of spoil either within the project or at off-site locations; and

ii. Waste dockets for any spoil disposed of to landfill sites.

6.3 Spoil Mitigation

a. Examples of spoil mitigation measures include:

i. Implementing the spoil re-use hierarchy;

ii. Handling spoil to minimise potential for air or water pollution; and

iii. Minimise traffic impacts associated with spoil removal.

7. Groundwater Management

7.1 Groundwater Management Objectives

a. The following groundwater management objectives will apply to construction:

  i. Reduce the potential for drawdown of surrounding groundwater resources;
  ii. Prevent the pollution of groundwater through appropriate controls; and
  iii. Reduce the potential impacts of groundwater dependent ecosystems.

7.2 Groundwater Management Implementation

a. The following content may be provided within other sub plans such as the Soil and Water Management Plan and Flora and Fauna Management Plan.

b. Principal Contractors will develop and implement a Groundwater Management Plan for their scope of works. The Groundwater Management Plan will include as a minimum:

  i. The groundwater mitigation measures as detailed in the environmental approval documentation;
  ii. The requirements of any applicable licence conditions;
  iii. Details of proposed extraction, use and disposal of groundwater, and measures to mitigate potential impacts to groundwater sources, incorporating monitoring, impact trigger definition and response actions for all groundwater sources potentially impacted by the SSI;
  iv. Evidence of consultation with the NSW Office of Water;
  v. The responsibilities of key project personnel with respect to the implementation of the plan;
  vi. Procedures for the treatment, testing and discharge of groundwater from the site;
  vii. Compliance record generation and management; and
  viii. Details of groundwater monitoring if required.

7.3 Groundwater Mitigation

a. Examples of groundwater mitigation measures include:

  i. Implementing all feasible and reasonable measures to limit groundwater inflows to stations and crossovers; and
  ii. Undertaking groundwater monitoring during construction (levels and quality) in areas identified as ‘likely’ and ‘potential’ groundwater dependent ecosystems.

8. Construction Traffic Management

Figure 5 – Castle Hill Station Site at the Intersection of Old Northern Rd and McMullen Ave

8.1 Construction Traffic Management Objectives

a. Construction traffic management will be managed using the following documentation, where relevant:

   i. Construction Traffic Management Plan;

   ii. Traffic Management Plan (for each work site);

   iii. Traffic Staging Plan (for road works);

   iv. Traffic Control Plan (for road works);

   v. Vehicle Movement Plan (internal to construction sites);

   vi. Pedestrian Management Plan (around construction sites); and

   vii. Parking Management Plan (loss of parking).

b. Principal Contractors will develop and implement a Construction Traffic Management Plan for their scope of works. The Construction Traffic Management Plan will as a minimum:

   i. Implement the traffic and transport mitigation measures as detailed in the environmental approval documentation;

   ii. be developed in consultation with the relevant road authority, CBD Coordinator General (CCO) and / or transport operator;

   iii. Set out the overall traffic management resources, processes and procedures for the management of traffic and transport during construction of the Project Works and Temporary Works;

iv. Identify types and volumes of construction vehicles and associated route and time restrictions;

v. Identify traffic generation from other major infrastructure developments, impacts from construction traffic and haulage routes;

vi. Identify potential activities that could result in the disruption to traffic and transport networks, including pedestrian, cyclist and public transport networks and during special events;

c. The individual construction traffic plans listed in (a) are to comply with and address the requirements of RMS Traffic Control at Worksites Manual AS 1742.3 Manual of uniform traffic control devices Part 3: Traffic control for works on roads, relevant Austroads Guides and RMS Supplements to Austroads and Australian Standards;

d. The process for the development of Traffic Management Plans (TMP) including the minimum requirements as detailed in Specification G10 and as required by the relevant road authorities.

e. The process for the development of Traffic Staging Plans (TSP) including the minimum requirements for these TSP including road design drawings showing traffic lane configurations for traffic passing through the site during various construction stages, including details of road alignment and geometry, intersection layouts, provision for buses and cyclists, work areas and pedestrian areas, drainage, signs and pavement markings;

f. The process for the development of Traffic Control Plans (TCP). The TCPs will set out the specific traffic and transport management arrangements to be implemented at specific locations during the construction of the Project Works and Temporary Works.

g. The process for the development of Vehicle Movement Plan (VMP). The content of a VMP will include:

i. A diagram showing the preferred travel paths for vehicles associated with a work site entering, leaving or crossing the through traffic stream. A VMP may be combined with or superimposed on a TCP; and

ii. The vehicle entry and exit points into the work area, and indicate clearly that these are the only points where interface with through traffic is permitted.

h. The process for the development of a Pedestrian Movement Plan (PMP). The content of the PMP will include:

i. A diagram showing the allocated travel paths for workers or pedestrians around or through a worksite. A PMP may be combined with or superimposed on a TCP; and

ii. A diagram showing all signs and devices used to guide the workers or pedestrians.

i. The process for the development of a Parking Management Plan (PkMP). The PkMP will identify:

i. Parking requirements and on and offsite parking arrangements and associated impacts;

ii. Remote parking arrangements and associated access between sites and public transport nodes;

iii. Communication and parking management measures; and

iv. Proposals for relocation of impacted users for any Sydney CBD kerbside use impacts during the construction period.

j. TfNSW and its Contractors will undertake liaison with agencies and the community regarding traffic management. This may involve:

   i. Establishment of a Traffic and Transport Liaison Group which could consist of representatives from Sydney Metro Contractors, TfNSW, CCO, WestConnex, RMS, TMC, NSW Police, relevant councils, emergency services, and bus operators. The group would review and provide feedback on:

      - Road Occupancy Licence (ROL) applications to monitor potential cumulative impacts from multiple ROLs operating concurrently in one area;
      - Be consulted on the preparation of Construction Traffic Management Plans and supporting Plans; and
      - Consultation with the CCO, RMS, TMC and others in relation to the approval of Construction Traffic Management Plans, supporting Plans, or related licences for works within and external to the CBD.

8.3 Construction Traffic Mitigation

a. Examples of traffic mitigation measures include:

   i. Minimising heavy vehicle movements during peak traffic times;
   ii. Avoidance of local roads for heavy vehicle routes, where feasible;
   iii. Providing for safe pedestrian and cyclist movements around the worksites; and
   iv. Where feasible and reasonable, contractors will provide its workforce with satellite car parking and buses to transport them to the worksites.

9. Construction Noise and Vibration Management

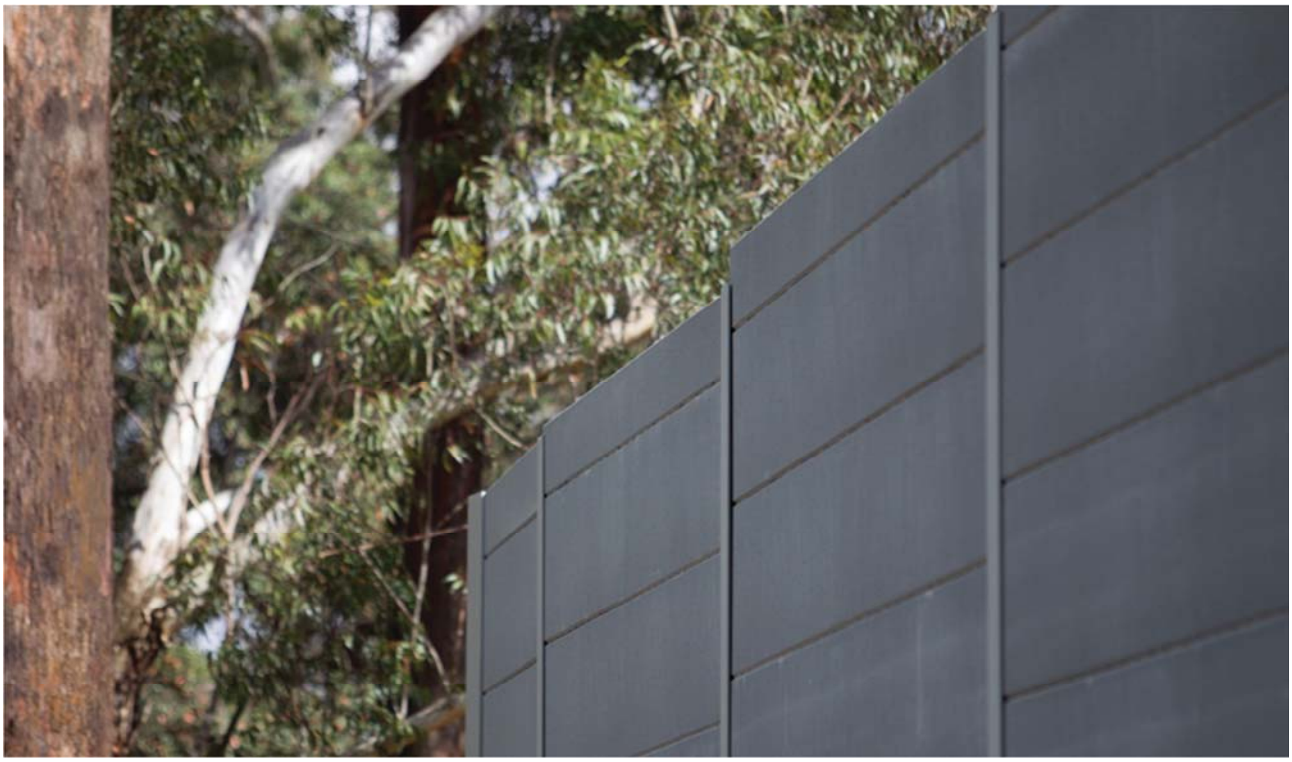


Figure 6 - Hebel Wall Noise Barrier at the Cheltenham Services Facility Site

9.1 Construction Noise and Vibration Management Objectives

a. The following noise and vibration management objectives will apply to construction:

i. Minimise unreasonable noise and vibration impacts on residents and businesses;

ii. Avoid structural damage to buildings or heritage items as a result of construction vibration;

iii. Undertake active community consultation; and

iv. Maintain positive, cooperative relationships with schools, childcare centres, local residents and building owners.

9.2 Construction Noise and Vibration Management Implementation

a. Principal Contractors will develop and implement a Construction Noise and Vibration Management Plan for their scope of works consistent with the Interim Construction Noise Guidelines (Department of Environment and Climate Change, 2009). The Construction Noise and Vibration Management Plan will include as a minimum:

   i. Identification of work areas, site compounds and access points;
   ii. Identification of sensitive receivers and relevant construction noise and vibration goals;
   iii. Be consistent with, and include the requirements of the noise and vibration mitigation measures as detailed in, the environmental approval documentation and the Sydney Metro Construction Noise and Vibration Strategy (CNVS);
   iv. Details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities (based on representative construction scenarios) that have the potential to generate noise or vibration impacts on surrounding sensitive receivers, in particular residential areas;
   v. Identification of feasible and reasonable procedures and mitigation measures to ensure relevant vibrations and blasting criteria are achieved, including a suitable blast program;
   vi. Community consultation requirements and Community notification provisions specifically in relation to blasting;
   vii. The requirements of any applicable EPL conditions;
   viii. Additional requirements in relation to activities undertaken 24 hours of the day, 7 days per week;
   ix. Pre-construction compliance requirements and hold points;
   x. The responsibilities of key project personnel with respect to the implementation of the plan;
   xi. Noise monitoring requirements;
   xii. Compliance record generation and management; and
   xiii. An Out of Hours Works Protocol applicable to all construction methods and sites.

b. Detailed Construction Noise and Vibration Impact Statements will be prepared for noise-intensive construction sites and or activities, to ensure the adequacy of the noise and vibration mitigation measures. Specifically, Construction Noise and Vibration Impact Statements will be prepared for EPL variation applications and works proposed to be undertaken outside of standard construction hours.

c. Noise and vibration monitoring would be undertaken for construction as specified in the CNVS and the EPL.

d. The following compliance records would be kept by Principal Contractors:

   i. Records of noise and vibration monitoring results against appropriate NMLs and vibration criteria; and
   ii. Records of community enquiries and complaints, and the Contractor’s response.

9.3 Construction Noise and Vibration Mitigation

a. All feasible and reasonable mitigation measures would be implemented in accordance with the CNVS. Examples of noise and vibration mitigation measures include:

   i. Construction hours will be in accordance with the working hours specified in Section 5.1;

   ii. Hoarding and enclosures will be implemented where required to minimise airborne noise impacts; and

   iii. The layout of construction sites will aim to minimise airborne noise impacts to surrounding receivers.

10. Heritage Management

Figure 7 –White Hart Inn Excavation Site

10.1 Heritage Management Objectives

a. The following heritage management objectives will apply to construction:

   i. Embed significant heritage values through any architectural design, education or physical interpretation;

   ii. Minimise impacts on items or places of heritage value;

   iii. Avoid accidental impacts on heritage items; and

   iv. Maximise worker's awareness of indigenous and non-indigenous heritage.

10.2 Heritage Management Implementation

a. Principal Contractors will develop and implement a Heritage Management Plan which will include as a minimum:

   i. Evidence of consultation with Registered Aboriginal Parties and the NSW Heritage Council;

   ii. Identify initiatives that will be implemented for the enhancement of heritage values and minimisation of heritage impacts, including procedures and processes that will be used to implement and document heritage management initiatives;

   iii. The heritage mitigation measures as detailed in the environmental approval documentation;

   iv. The responsibilities of key project personnel with respect to the implementation of the plan;

   v. Procedures for interpretation of heritage values uncovered through salvage or excavation during detailed design;

   vi. Procedures for undertaking salvage or excavation of heritage relics or sites (where relevant), consistent with and any recordings of heritage relics prior to works commencing that would affect them;

   vii. Details for the short and / or long term management of artefacts or movable heritage;

   viii. Details of management measures to be implemented to prevent and minimise impacts on heritage items (including further heritage investigations, archival recordings and/or measures to protect unaffected sites during construction works in the vicinity);

   ix. Procedures for unexpected heritage finds, including procedures for dealing with human remains;

   x. Heritage monitoring requirements; and

   xi. Compliance record generation and management.

b. The Contractor's regular inspections will include checking of heritage mitigation measures.

c. Compliance records will be retained by the Contractor. These will include:

   i. Inspections undertaken in relation to heritage management measures;

   ii. Archival recordings undertaken of any heritage item;

   iii. Unexpected finds and stop work orders; and

   iv. Records of any impacts avoided or minimised through design or construction methods.

10.3 Heritage Mitigation

a. Examples of heritage mitigation measures include:

   i. Any heritage item not affected by the works will be retained and protected throughout construction;

   ii. During construction undertake professional archaeological investigation, excavation, and reporting of any historical Indigenous heritage sites of state significance which will be affected. Reporting may be completed as construction progresses;

   iii. Undertake archival recordings of all non-Indigenous heritage items affected by the works prior to commencement of works; and

   iv. Implement unexpected heritage find procedures for Indigenous and non-Indigenous heritage items.

11. Flora and Fauna Management

Figure 8 - Demarcation of Retained Flora

11.1 Flora and Fauna Management Objectives

a. The following flora and fauna management objectives will apply to construction:

i. Minimise impacts on flora and fauna;

ii. Design waterway modifications and crossings to incorporate best practice principles;

iii. Retain and enhance existing flora and fauna habitat wherever possible; and

iv. Appropriately manage the spread of weeds and plant pathogens.

11.2 Flora and Fauna Management Implementation

a. Principal Contractors will develop and implement a Flora and Fauna Management Plan which will include as a minimum:

   i. The ecological mitigation measures as detailed in the environmental approval documentation;

   ii. The responsibilities of key project personnel with respect to the implementation of the plan;

   iii. Procedures for the clearing of vegetation and the relocation of flora and fauna;

   iv. Details on the locations, monitoring program and use of nest boxes by fauna;

   v. Procedures for the demarcation and protection of retained vegetation, including all vegetation outside and adjacent to the construction footprint;

   vi. Plans for impacted and adjoining areas showing vegetation communities; important flora and fauna habitat areas; locations where threatened species, populations or ecological communities have been recorded;

   vii. Vegetation management plan(s) for sites where native vegetation is proposed to be retained;

   viii. Identification of measures to reduce disturbance to sensitive fauna;

   ix. Rehabilitation details, including identification of flora species and sources, and measures for the management and maintenance of rehabilitated areas (including duration of the implementation of such measures);

   x. Weed management measures focusing on early identification of invasive weeds and effective management controls;

   xi. A procedure for dealing with unexpected EEC threatened species identified during construction, including cessation of work and notification of the Department, determination of appropriate mitigation measures in consultation with the OEH (including relevant relocation measures) and updating of ecological monitoring or off-set requirements;

   xii. Details on the methodology for vegetation mapping and survey;

   xiii. Ecological monitoring requirements; and

   xiv. Compliance record generation and management.

b. Principal Contractors would undertake the following ecological monitoring as a minimum:

   i. A pre-clearing inspection will be undertaken prior to any native vegetation clearing by a suitable qualified ecologist and the Contractor's Environmental Manager (or delegate). The pre-clearing inspection will include, as a minimum:

      - Identification of hollow bearing trees or other habitat features;
      - Identification of any threatened flora and fauna;
      - A check on the physical demarcation of the limit of clearing;
      - An approved erosion and sediment control plan for the worksite; and
      - The completion of any other pre-clearing requirements required by any project approvals, permits or licences.

ii. The completion of the pre-clearing inspection will form a HOLD POINT requiring sign-off from the Contractor's Environmental Manager (or delegate) and a qualified ecologist; and

iii. A post clearance report, including any relevant Geographical Information System files, will be produced that validates the type and area of vegetation cleared including confirmation of the number of hollows impacted and the corresponding nest box requirements to offset these impacts.

c. The Principal Contractor's regular inspections will include a check on the ecological mitigation measures and project boundary fencing.

d. The following compliance records would be kept by the Principal Contractor:

   i. Records of pre-clearing inspections undertaken;

   ii. Records of the release of the pre-clearing hold point; and

   iii. Records of ecological inspections undertaken.

11.3 Flora and Fauna Mitigation

a. Examples of flora and fauna mitigation measures include:

   i. Areas to be retained and adjacent habitat areas will be fenced off prior to works to prevent damage or accidental over clearing;

   ii. Clearing will follow a two-stage process as follows:

      - Non-habitat trees will be cleared first after sign-off of the pre-clearing inspection; and
      - Habitat trees will be cleared no sooner than 48 hours after non-habitat trees have been cleared. A suitably qualified ecologist will be present on site during the clearing of habitat trees. Felled habitat trees will be left on the ground for 24 hours or inspected by the ecologist prior to further processing.

   iii. Weed management is to be undertaken in areas affected by construction prior to any clearing works in accordance with the Noxious Weeds Act 1993.

12. Visual Amenity Management

12.1 Visual Amenity Management Objectives

a. The following visual and landscape management objectives will apply to the construction of the project:

i. Minimise impacts on existing landscape features as far as feasible and reasonable;

ii. Ensure the successful implementation of the Landscape Design; and

iii. Reduce visual impact of construction to surrounding community.

12.2 Visual Amenity Management Implementation

a. Principal Contractors will develop and implement a Visual Amenity Management Plan for temporary works which will include as a minimum:

i. The visual mitigation measures as detailed in the environmental approval documentation for construction;

ii. Input from an experienced Landscape or Urban Designer;

iii. The maintenance of outward facing elements of site hoarding or noise barriers, including the removal of graffiti and weeds;

iv. Apply the principles of Australian Standard 4282-1997 Control of the obtrusive effects of outdoor lighting and relevant safety design requirements and detail mitigation measures to minimise lighting impacts on sensitive receivers for all permanent, temporary and mobile light sources;

v. Identify the processes and procedures that will be used for the incorporation of the principles of Crime Prevention Through Environmental Design (CPTED) in the design and construction of any temporary site facilities; and

vi. Compliance record generation and management.

b. Visual and landscape measures will be incorporated into the Principal Contractor's regular inspections including checking the health of retained vegetation around site boundaries, checking the condition of any site hoarding and acoustic sheds, and checking the position and direction of any sight lighting.

c. The Contractor will retain compliance records of any inspections undertaken in relation to visual and landscape measures.

12.3 Visual Amenity Mitigation

a. Examples of visual amenity mitigation measures include:

i. Wherever feasible and reasonable, vegetation around the perimeter of the construction sites will be maintained;

ii. Temporary construction works will be designed with consideration of urban design and visual amenity as per Section 4.4; and

iii. Temporary site lighting, for security purposes or night works will be installed and operated in accordance with AS4282:1997 Control of the Obtrusive Effect of Outdoor Lighting.

13. Carbon and Energy Management

13.1 Carbon and Energy Management Objectives

a. The following carbon and energy management objectives will apply to construction:

   i. Reduce energy use and carbon emissions during construction;

   ii. Support innovative and cost effective approaches to energy efficiency, low carbon / renewable energy sources and energy procurement; and

   iii. Design to reduce energy use and carbon emissions during operations.

13.2 Carbon and Energy Management Implementation

a. Principal Contractors will develop and implement a Carbon and Energy Management Plan that will include, as a minimum:

   i. The carbon and energy mitigation measures as detailed in the environmental approval documentation;

   ii. The relevant requirements of the Sydney Metro Environment and Sustainability Policy and the Sydney Metro Sustainability Strategy;

   iii. The responsibilities of key project personnel with respect to the implementation of the plan;

   iv. The low carbon strategies and initiatives that will be implemented to minimise the carbon emissions associated with construction;

   v. The energy efficiency strategies and initiatives that will be implemented to minimise energy use associated with construction;

   vi. Carbon emission estimates determined using a carbon footprint assessment undertaken in accordance with ISO 14064-1, ISO14064-2 and ISO14064-3 that incorporates direct and indirect emissions associated with construction; and

   vii. Compliance record generation and management.

b. Reporting of carbon and energy will be undertaken throughout the construction works in accordance with the National Greenhouse and Energy Reporting Act 2007.

c. The Contractors would be required to retain appropriate records and prepare carbon footprint assessments (inclusive of Scope 1, 2 and 3 emissions) at various stages of construction.

13.3 Carbon and Energy Mitigation

a. Examples of carbon and energy mitigation measures include:

   i. Equipment and material selection will have consideration of energy efficiencies;

   ii. Construction workers will be encouraged to use sustainable transport options and green travel plans will be developed;

   iii. Inclusion of renewable energy sources to power temporary facilities and equipment where feasible;

   iv. Designing and operating Site offices for energy efficiency;

   v. Offsetting a portion of construction greenhouse gas emissions; and

   vi. Efficient operation of vehicles and equipment.

14. Materials Management

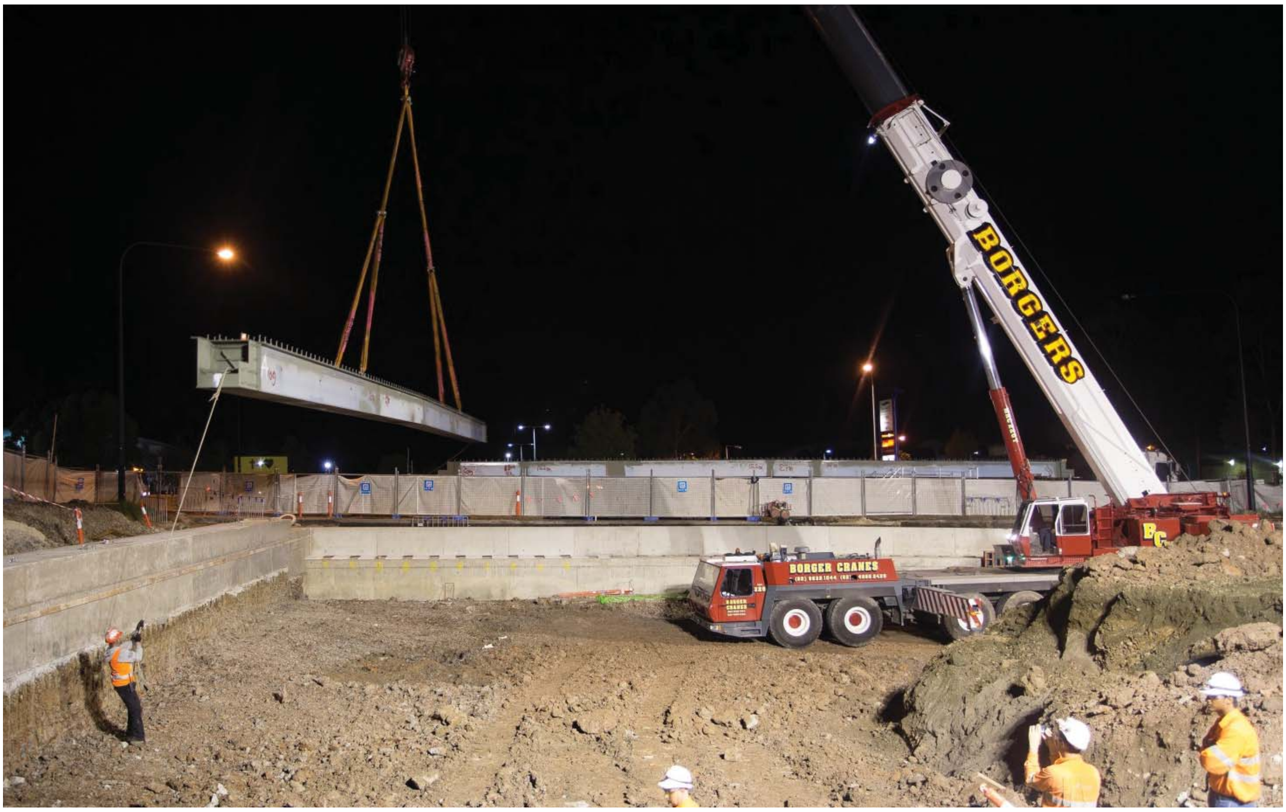


Figure 9 - Sydney Monorail Beams being re-used at the Norwest Station Site

14.1 Materials Management Objectives

a. The following materials management objectives would apply to the construction of the project:

i. Reduce material use throughout the project life-cycle;

ii. Consider embodied impacts in materials selection;

iii. Use recycled materials;

iv. Recycle and reuse materials onsite; and

v. Influence subcontractors and materials suppliers to adopt sustainability objectives in their works and procurement.

14.2 Materials Management Implementation

a. Principal Contractors will be required to develop and implement a Sustainable Procurement Policy that will include as a minimum:

   i. The materials mitigation measures as detailed in the environmental approval documentation;
   ii. The relevant requirements of the City & Southwest Environment and Sustainability Policy and the City & Southwest Sustainability Strategy;
   iii. The responsibilities of key project personnel with respect to the implementation of the policy;
   iv. Compliance record generation and management;
   v. Ethical sourcing of materials; and
   vi. Local sourcing.

b. The Contractors will be required to retain records detailing the consideration of sustainability in the procurement of all materials.

14.3 Materials Mitigation

a. Examples of materials mitigation measures include:

   i. Consideration of quality and durability in the procurement of materials;
   ii. Using recycled materials;
   iii. Using materials with a lower embodied impact;
   iv. Using recycled steel in concrete reinforcement;
   v. Developing deconstruction plans to enable recycling and reuse at end-of-life;
   vi. Using low-VOC, low emission materials;
   vii. Using sustainably sourced timber and wood products;
   viii. Low-carbon concrete; and
   ix. Consideration of whole-of-life costs during procurement.

15. Soil and Water Management

Figure 10 - Erosion and Sediment Controls at the Cudgegong Rd Site

15.1 Soil and Water Management Objectives

a. The following soil and water management objectives will apply to construction:

   i. Minimise pollution of surface water through appropriate erosion and sediment control;

   ii. Maintain existing water quality of surrounding surface watercourses; and

   iii. Source construction water from non-potable sources, where feasible and reasonable.

15.2 Soil and Water Implementation

a. Principal Contractors will develop and implement a Soil and Water Management Plan for their scope of works. The Soil and Water Management Plan will include as a minimum:

i. The surface water and flooding mitigation measures as detailed in the environmental approval documentation;

ii. Details of construction activities and their locations, which have the potential to impact on water courses, storage facilities, stormwater flows, and groundwater;

iii. Surface water and ground water impact assessment criteria consistent with the principles of the Australian and New Zealand Environment Conservation Council (ANZECC) guidelines;

iv. Management measures to be used to minimise surface and groundwater impacts, including identification of water treatment measures and discharge points, details of how spoil and fill material required by the SSI will be sourced, handled, stockpiled, reused and managed; erosion and sediment control measures; salinity control measures and the consideration of flood events;

v. A contingency plan, consistent with the Acid Sulphate Soils Manual (EPA 1998), to deal with the unexpected discovery of actual or potential acid sulphate soils, including procedures for the investigation, handling, treatment and management of such soils and water seepage;

vi. Management measures for contaminated material (soils, water and building materials) and a contingency plan to be implemented in the case of unanticipated discovery of contaminated material, including asbestos, during construction;

vii. A description of how the effectiveness of these actions and measures would be monitored during the proposed works, clearly indicating how often this monitoring would be undertaken, the locations where monitoring would take place, how the results of the monitoring would be recorded and reported, and, if any exceedance of the criteria is detected how any non-compliance can be rectified;

viii. The requirements of any applicable EPL conditions;

ix. The responsibilities of key project personnel with respect to the implementation of the plan;

x. Procedures for the development and implementation of Progressive Erosion and Sediment Control Plans;

xi. Identification of locations where site specific Stormwater and Flooding Management Plans are required; and

xii. Compliance record generation and management.

b. Principal Contractors will develop and implement Progressive Erosion and Sediment Control Plans (ESCPs) for all active worksites in accordance with Managing Urban Stormwater: Soils & Construction Volume 1 (Landcom, 2004) (known as the “Blue Book”). The ESCPs will be approved by the Contractor’s Environmental Manager (or delegate) prior to any works commencing (including vegetation clearing) on a particular site. Copies of the approved ESCP will be held by the relevant Contractor personnel including the Engineer and the Site Foreman.

c. ESCPs will detail all required erosion and sediment control measures for the particular site at the particular point in time and be progressively updated to reflect the current site conditions. Any amendments to the ESCP will be approved by the Contractor’s Environmental Manager (or delegate).

d. Principal Contractors will develop and implement Stormwater and Flooding Management Plans for the relevant construction sites. These plans will identify the appropriate design standard for flood mitigation based on the duration of construction, proposed activities and flood risks. The plan will develop procedures to ensure that threats to human safety and damage to infrastructure are not exacerbated during the construction period.

e. Principal Contractors will undertake the following soil and water monitoring as a minimum:

   i. Weekly inspections of the erosion and sediment control measures. Issues identified would be rectified as soon as practicable;

   ii. Additional inspections will be undertaken following significant rainfall events (greater than 20 mm in 24 hours); and

   iii. All water will be tested (and treated if required) prior to discharge from the site in order to determine compliance with the parameters of the EPL. No water will be discharged from the site without written approval of the Contractor's Environmental Manager (or delegate). This is to form a HOLD POINT.

f. The following compliance records will be kept by the Principal Contractors:

   i. Copies of current ESCPs for all active construction sites;

   ii. Records of soil and water inspections undertaken;

   iii. Records of testing of any water prior to discharge; and

   iv. Records of the release of the hold point to discharge water from the construction site to the receiving environment.

g. The following water resources management objectives will apply to the construction of the project:

   i. Minimise demand for, and use of potable water;

   ii. Maximise opportunities for water re-use from captured stormwater, wastewater and groundwater;

   iii. Examples of measures to minimise potable water consumption include:

      - Water efficient controls, fixtures and fittings in temporary facilities;
      - Collecting, treating and reusing water generated in tunnelling operations, concrete batching and casting facility processes;
      - Using recycled water or treated water from onsite sources in the formulation of concrete;
      - Harvesting and reusing rainwater from roofs of temporary facilities;
      - Using water from recycled water networks;
      - Collecting, treating and reusing groundwater and stormwater;
      - Using water efficient construction methods and equipment; and
      - Providing designated sealed areas for equipment wash down.

15.3 Soil and Water Mitigation

a. Examples of surface water and flooding mitigation measures include:

   i. Clean water will be diverted around disturbed site areas, stockpiles and contaminated areas;

   ii. Control measures will be installed downstream of works, stockpiles and other disturbed areas;

iii. Exposed surfaces will be minimised, and stabilised / revegetated as soon feasible and reasonable upon completion of construction;

iv. Dangerous good and hazardous materials storage will be within bunded areas with a capacity of 110 per cent of the maximum single stored volume; and

v. Spill kits will be provided at the batch plants, storage areas and main work sites.

16. Air Quality

Figure 11 - Dust Mitigation at Norwest Station Site

16.1 Air Quality Management Objectives

a. The following air quality management objectives will apply to construction:

i. Minimise gaseous and particulate pollutant emissions from construction activities as far as feasible and reasonable; and

ii. Identify and control potential dust and air pollutant sources.

16.2 Air Quality Management Implementation

a. Principal Contractors will develop and implement an Air Quality Management Plan which will include, as a minimum:

i. The air quality mitigation measures as detailed in the environmental approval documentation;

ii. The requirements of any applicable EPL conditions;

iii. Site plans or maps indicating locations of sensitive receivers and key air quality / dust controls;

iv. The responsibilities of key project personnel with respect to the implementation of the plan;

v. Air quality and dust monitoring requirements; and
vi. Compliance record generation and management.

b. Air quality and dust monitoring will involve the following as a minimum:
    i. Meteorological conditions will be monitored and appropriate responses will be organised and undertaken periodically by the Principal Contractor;
    ii. Regular visual monitoring of dust generation from work zones; and
    iii. Monitoring emissions from plant and construction vehicles to ensure they have appropriate emission controls and are being maintained correctly.

c. The following compliance records will be kept by the Principal Contractor:
    i. Records of any meteorological condition monitoring;
    ii. Records of any management measures implemented as a result of adverse, windy weather conditions; and
    iii. Records of air quality and dust inspections undertaken.

16.3 Air Quality Mitigation

a. Examples of air quality mitigation measures include:
    i. Plant and equipment will be serviced and maintained in good working order to reduce unnecessary emissions from exhaust fumes;
    ii. Water suppression will be used for active earthwork areas, stockpiles, unsurfaced haul roads and loads of soil being transported to reduce wind-blown dust emissions;
    iii. Wheel-wash facilities or rumble grids will be provided and used near the site exit points, as appropriate; and
    iv. Dust extraction and filtration systems will be installed for tunnel excavation works and deep excavation with limited surface exposure.

17. Waste Management & Recycling

17.1 Waste Objectives

a. The following waste objectives will apply to construction:

   i. Minimise waste throughout the project life-cycle; and

   ii. Waste management strategies will be implemented in accordance with the *Waste Avoidance and Resource Recovery Act 2001* management hierarchy as follows:

      - Avoidance of unnecessary resource consumption;
      - Resource recovery (including reuse, reprocessing, recycling and energy recovery); and
      - Disposal.

b. Targets for the recovery, recycling or reuse of construction waste, and beneficial reuse of spoil will be provided by the Principal Contractor.

17.2 Waste Implementation

a. Principal Contractors will develop and implement a Waste Management and Recycling Plan which will include as a minimum:

   i. The waste management and recycling mitigation measures as detailed in the environmental approval documentation;

   ii. The responsibilities of key project personnel with respect to the implementation of the plan;

   iii. Waste management and recycling monitoring requirements;

   iv. A procedure for the assessment, classification, management and disposal of waste in accordance with the Waste Classification Guidelines (DECC, 2008); and

   v. Compliance record generation and management.

b. Principal Contractors will undertake the following waste monitoring as a minimum:

   i. Weekly inspections will include checking on the waste storage facilities on site; and

   ii. All waste removed from the site will be appropriately tracked from 'cradle to grave' using waste tracking dockets.

c. Principal Contractors will report all necessary waste and purchasing information to TfNSW as required for TfNSW to fulfil their WRAPP reporting requirements.

d. Compliance records will be retained by the Principal Contractors in relation to waste management including records of inspections and waste dockets for all waste removed from the site.

17.3 Waste Mitigation

a. Examples of waste management and recycling mitigation measures include:

   i. All waste materials removed from the sites will be directed to an appropriately licensed waste management facility;

   ii. The use of raw materials (noise hoarding, site fencing, etc...) will be reused or shared, between sites and between construction contractors where feasible and reasonable; and

   iii. Recyclable wastes, including paper at site offices, will be stored separately from other wastes.

18. Acronyms

Acronym	
CEMP	Construction Environmental Management Plan
CNVS	Construction Noise and Vibration Strategy
DP&E	Department of Planning and Environment (Formerly Department of Planning and Infrastructure)
EIS	Environmental Impact Statement
EMF	Environmental Management Framework
EMS	Environmental Management System
EPA	Environment Protection Authority
EP&A Act	Environmental Planning and Assessment Act 1979
EPL	Environment Protection Licence (issued by EPA under the POEO Act)
ER	Environmental Representative
ESCP	Erosion and Sediment Control Plan
NOHSC	National Occupational Health and Safety Commission
OEH	Office of Environment and Heritage (Formerly DECCW)
POEO Act	Protection of the Environment Operation Act 1997
RMS	Roads and Maritime Service (Formerly RTA)
TBM	Tunnel Boring Machine
TfNSW	Transport for NSW

Appendix A – Environment and Sustainability Policy

Environment & Sustainability Policy

This Policy reflects a commitment in our delivery of the Sydney Metro program to:

- Align with, and support, Transport for NSW (TfNSW) Environment & Sustainability Policy.
- Optimise sustainability outcomes, transport service quality, and cost effectiveness.
- Develop effective and appropriate responses to the challenges of climate change, carbon management, resource and waste management, land use integration, customer and community expectation, and heritage and biodiversity conservation.
- Be environmentally responsible, by avoiding pollution, enhancing the natural environment and reducing the project ecological footprint, while complying with all applicable environmental laws, regulations and statutory obligations.
- Be socially responsible by delivering a workforce legacy which benefits individuals, communities, the project and industry, and is achieved through collaboration and partnerships.

To deliver on these commitments, the Sydney Metro team will:

Industry leadership

- Implement coordinated and transparent decision making, by engaging with stakeholders and suppliers, encouraging innovation and demonstrating sustainability leadership.
- Explore new benchmarks for the transport infrastructure sector by requiring high standards from our designers, contractors and suppliers, building on experience gained through development of Sydney Metro Northwest.

Community and customer

- Provide accessible, safe, pleasurable, and convenient access and transport service for all customers.
- Establish positive relationships with community and stakeholders to maximise opportunities to add value to local communities.

Land use integration and place making

- Create desirable places, promote liveability, cultural heritage, and optimise both community and economic benefit.
- Balance transit oriented development opportunities with stakeholder expectations.

Embedding environmental and social sustainability

- Establish robust sustainability objectives and targets.
- Maintain an environmental management system that is integrated into all our project activities.
- Ensure thorough and open environmental assessment processes are developed and maintained.
- Develop and maintain an environmental management framework to embed best practice pollution management and sustainable outcomes during construction.
- Apply effective assurance processes to monitor performance against the project environment and sustainability objectives and identify appropriate reward or corrective action, as required.
- Apply environment and sustainability specific processes to the procurement of delivery activities.

Accountability

- Undertake public sustainability reporting.
- Hold employees and contractors accountable for proactively meeting their environmental and social sustainability responsibilities.
- Provide appropriate training and resources necessary to meet our responsibilities.

Rodd Staples - Program Director, Sydney Metro

Attachment B - SM ES-ST-209 Sydney Metro Environment Sustainability Policy Final

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CONSTRUCTION ENVIRONMENTAL MANAGEMENT FRAMEWORK

> August 2017

Appendix E

Construction Noise and Vibration Strategy

Integrated Management System

Sydney Metro City & Southwest Construction Noise and Vibration Strategy

Report No 610.14213-R3

Sydney Metro Integrated Management System (IMS)

Applicable to:	Sydney Metro City & Southwest
Author:	Mark Russell Associate Consultant SLR Consulting Australia Pty Ltd
System owner:	Transport for NSW
Status:	Final
Version:	0.4 (v1.0 will be in Planning Approval)
Date of issue:	08 August 2016
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1. FOREWORD

The Department of Environment, Climate Change and Water NSW (now the Environmental Protection Authourity EPA) issued the Interim Construction Noise Guideline (ICNG) in July 2009.

The main objectives of the ICNG are stated in Section 1.3, a portion of which is presented below:

> *"The main objectives of the Guideline are to:*
>
> - *promote a clear understanding of ways to identify and minimise noise from construction works*
> - *focus on applying all 'feasible' and 'reasonable' work practices to minimise construction noise impacts*
> - *encourage construction to be undertaken only during the recommended standard hours unless approval is given for works that cannot be undertaken during these hours*
> - *streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage*
> - *provide flexibility in selecting site-specific feasible and reasonable work practices in order to minimise noise impacts."*

The ICNG guideline (in Section 7.3) also encourages organisations involved with construction, maintenance or upgrading works (such as Sydney Metro) to develop their own best-practice techniques for managing construction noise.

In line with this recommendation the purpose of this 'Construction Noise and Vibration Strategy' is to document how Sydney Metro proposes to manage construction noise and vibration for the Sydney Metro and SouthWest project including any potential extensions.

2. PURPOSE AND SCOPE

2.1. Background

People are usually more tolerant to noise and vibration during the construction phase of proposals than during normal operation. This response results from recognition that the construction emissions are of a temporary nature – especially if the most noise-intensive construction impacts occur during the less sensitive daytime period. For these reasons, acceptable noise and vibration levels are normally higher during construction than during operations.

Construction often requires the use of heavy machinery which can generate high noise and vibration levels at nearby buildings and receivers. For some equipment, there is limited opportunity to mitigate the noise and vibration levels in a cost-effective manner and hence the potential impacts would be minimised by using feasible and reasonable management techniques.

At any particular location, the potential impacts can vary greatly depending on factors such as the relative proximity of sensitive receivers, the overall duration of the construction works, the intensity of the noise and vibration levels, the time at which the construction works are undertaken and the character of the noise or vibration emissions.

The construction noise and vibration emissions associated with a large infrastructure project such as Sydney Metro will cause disturbance to adjacent communities. This is of particular relevance in urban areas, such as in the Sydney CBD, where many sensitive receivers (not just residential) are present.

Due to the nature of this large infrastructure project a significant number of activities will be required outside normal construction hours as work during daytime periods would be highly disruptive to road traffic for commuters. In addition, noise and vibration impacts for this project are generally expected to have a duration of several years. It is therefore important that reasonable and feasible mitigation measures (as defined in the ICNG) are identified and implemented to ensure that construction noise and vibration impacts are reduced to a minimum.

2.2. Strategy Objectives

Generally the strategy is intended to provide a single interface for the large number of policies, guidelines, standards and regulations that apply to a large infrastructure project such as Sydney Metro. Where possible the strategy consolidates these information sources eg vibration criteria from numerous sources are collated into one section of this strategy for ease of reference. Further, the strategy aims to provide interpretation of the reference documents which are specific to the Metro project. Where the reference documents are found to have insufficient detail the strategy provides additional assessment criteria and methodologies.

The specific objectives of this Construction Noise and Vibration Strategy are as follows:

- Applying the strategy during the different construction phases of the project
- Environmental Protection Licence (EPL) conditions
- Construction noise and vibration guidelines to apply to the project (additional guidance to complement the ICNG)
- Construction noise and vibration assessment methodology
- Standard noise and vibration mitigation measures for the project
- Additional noise and vibration mitigation measures for the project
- Out of hours (OOH) Work
- Monitoring, auditing and reporting
- Construction noise and vibration documentation requirements

2.3. Distribution and Use

This document may be used in the development of, or referred to in:

- Environmental impact assessment documents
- Design and construction environmental management documents
- Contract documents
- Approvals and licences (subject to the agreement of the relevant regulatory authority)

2.4. Strategy Review

The strategy will be reviewed, as a minimum, annually to ensure that it meets the needs of the community, Sydney Metro and the contractors engaged on Sydney Metro projects. This document does not take precedence over approval or licence conditions and will be reviewed as required in response to the release of relevant approvals, licences, guidelines, standards and policies dealing with construction noise and vibration.

3. APPLYING THE STRATEGY

The planning procedure for all infrastructure projects requires that a detailed Environmental Assessment of the construction phases of the proposal be completed. As construction contractors are not typically appointed until much later in a project's timeline, the exact construction methodology they will use for a particular project may not be known during the environmental assessment stage.

It is expected that conservative assumptions would be incorporated at early stages of the project approval process and these must not unduly restrict innovation (eg construction methods or mitigation) at later design stages. This reflects the refinement of construction methodologies with subsequent stages of the project.

This document therefore defines the strategies by which construction noise and vibration impacts are to be minimised on Sydney Metro projects throughout the construction of a project by recognising the changing assessment requirements for each construction phase.

Table 1 outlines the level of detail expected from the assessment process (refer to Section 7) at the following stages of the project:

- Environmental Impact Statement / Environmental Assessment
- In delivery / pre-construction impact statements

Table 1: Summary of Assessment Detail Required During the Various Stages of the Project

Assessment Input	Environmental Impact Statement / Environmental Assessment	In Delivery / Pre-construction Impact Statements
Construction Scenarios / Equipment List	Construction scenarios defined by project team, based on potential construction methodologies known at the time	Construction scenarios defined by construction team. These are expected to include finalised equipment lists, itemising the realistic worst-case plant proposed to be used at any one time, and in any one location
Modelled works location	Works location by scenario (or group of scenarios) ie different locations for different works	Works location by works scenario ie specific locations for each works
Background noise monitoring	Background noise monitoring required to determine RBL at locations representative of worst-affected receiver areas adjacent to the works areas	Supplementary noise monitoring required to determine RBL at locations representative of worst-affected receiver areas adjacent to the works areas where noise survey data is not current (ie more than 5 years old)
Study Area	The study area must, as a minimum, include receivers subjected to predicted $L_{Aeq(15minute)} \geq$ RBL+5dB for the applicable time period. Vibration level predictions up to 100 m	Predict noise and vibration levels to the sensitive receivers within the area surrounding the works, to include all receivers where the $L_{Aeq(15minute)} \geq$ RBL +5dB and the vibration screening criteria are exceeded during the applicable time periods.

Assessment Input	Environmental Impact Statement / Environmental Assessment	In Delivery / Pre-construction Impact Statements
Reporting	n/a	Predictions would be undertaken for the proposed time period of the works
Assessment of mitigation	Demonstration that assessment of this stage includes reasonable and feasible mitigation measures	Based on these predictions the Construction Noise Management Plan (CNMP) shall identify all reasonable and feasible mitigation measures to minimise noise and vibration from construction. Sections 7 and 8 identify the standard and additional mitigation measures to be included where applicable in the CNMP. Eg. Detailed vibration assessments to include dilapidation surveys, continuous vibration monitoring and accurate vibration transfer measurements (site law measurements) for all buildings with the potential to exceed the screening criteria for vibration.
Documentation	n/a	Implementation of the EPL conditions, or as modified by subsequent CNVIS (eg for OOHW)

4. ENVIRONMENTAL PROTECTION LICENCES (EPL)

Environmental Protection Licences are a fundamental noise control requirement for large infrastructure projects. These licences often provide detailed construction noise and vibration criteria and management measures that are tailored to the specifics of individual projects. To use this strategy effectively the time-line of assessments, approvals and licences would be understood and the necessary interaction of this strategy, the CNIS reports it generates and the EPL issued for the project.

4.1. Time-line of Assessments, Approvals and the EPL

The general time-line for this process with respect to noise and vibration from construction activities is outlined below:

1. Project concept. Preliminary high-level CNIS and CNMP reports.
2. Department of Planning Issues the Conditions of Approval for the project.
3. Environmental Impact Statement (EIS). Preliminary but more detailed CNIS and CNMP reports based on a complete concept design.
4. Project Approval from the Department of Planning.
5. Contactor Tender and Award.
6. Contractor Detailed Design. Mature CNIS and CNMP reports based on the detailed design.
7. Contractor application for Environmental Protection License for the project.
8. Licence award by the Environmental Protection Agency EPL.
9. Construction commences.
10. Ongoing of review of construction methodology and project noise and vibration issues.
11. Re-assess CNIS and CNMP based on new inputs (if necessary).
12. Consistency Assessment
13. Contractor application for amendments to the EPL.
14. Approval of the amendments to the EPL.

As can been seen from the above time-line this Strategy is used through the planning, approval and construction stages. Steps 10 through to 14 can be repeated to review and add to the EPL conditions, if necessary, during the construction stage.

5. NOISE AND VIBRATION GUIDELINES

5.1. Construction Noise Metrics

The three primary noise metrics used to describe construction noise emissions in the modelling and assessments are:

$L_{A1(1minute)}$ The typical 'maximum noise level for an event', used in the assessment of potential sleep disturbance during night-time periods. Alternatively, assessment may be conducted using the L_{Amax} or maximum noise level

$L_{Aeq(15minute)}$ The 'energy average noise level' evaluated over a 15-minute period. This parameter is used to assess the potential construction noise impacts.

L_{A90} The 'background noise level' in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The $L_{Aeq(15minute)}$ construction noise management levels are based on the L_{A90} background noise levels.

The subscript 'A' indicates that the noise levels are filtered to match normal hearing characteristics (A weighted).

5.2. Construction Hours

Where possible, works will be completed during the standard day time construction hours of Monday to Friday 7.00 am to 6.00 pm and Saturdays 8.00 am to 1.00 pm. However, the nature of the project means evening and night work are required throughout the construction program. Many of the construction scenarios for this project will require 24/7 operation. These scenarios include:

- Excavation of station shafts
- Excavation of the station caverns
- Operation of the tunnel boring machines
- Spoil removal and transport from site

Out of Hours Works (OOHWs) are to be included in the assessment for all proposed works at all locations in order to inform the scheduling of construction activity and management of noise during the detailed design phase. It is anticipated that the finalised requirements for OOHWs would be determined at a later design stage. It is understood that any OOHWs would be subject to a separate approval on a case-by-case basis and would likely require approval under the project's Environmental Protection Licence (EPL).

5.3. Construction Noise Management Levels (NML)

Construction Noise Management Levels (NML) for all Sydney Metro projects will be determined in accordance with the procedures nominated in the DECCW's "Interim Construction Noise Guideline" dated July 2009 (ICNG, 2009). The following information is intended to supplement the ICNG with respect to the unique requirements of the Metro project.

5.3.1. Residences and Other Sensitive Land Uses

Table 2 sets out the noise management levels and how they are to be applied. This approach intends to provide respite for residents exposed to excessive construction noise outside the recommended standard hours whilst allowing construction during the recommended standard hours without undue constraints.

Table 2 the rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (as defined in the EPA "Industrial Noise Policy" dated January 2000).

Table 2: Noise at Residences Using Quantitative[1]

Time of Day	Management Level LAeq(15minute)[2]	How to Apply
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm Saturday 8.00 am to 1.00 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq(15minute) is greater than the noise affected level, the proponent would apply all feasible and reasonable work practices to minimise noise. The proponent would 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.
No work on Sundays or public holidays	Highly noise affected 75 dB	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 proponent would consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent would communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.
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 would 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 would negotiate with the community. For guidance on negotiating agreements see Section 7.2.2 of the ICNG.

Note 1: Adopted from the ICNG.

Note 2: Noise levels apply at the property boundary that is most exposed to construction noise. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence.

Table 3 presents management levels for noise at other sensitive land uses based on the principle that the characteristic activities for each of these land uses would not be unduly disturbed. The noise management levels apply only to when the property is being used, for example classrooms during school hours. Internal noise levels are to be assessed at the centre of the occupied room. External noise levels are to be assessed at the most-affected point within 50 m of the area boundary.

Table 3: Noise at Other Sensitive Land Uses Using Quantitative Assessment[1]

Land Use	Management Level, $L_{Aeq(15minute)}$ (Applies When Land Use is being Utilised)
Classrooms at schools and other educational institutions	Internal noise level 45 dB
Hospital wards and operating theatres	Internal noise level 45 dB
Places of worship	Internal noise level 45 dB
Active recreation areas (such as parks and sports grounds or playgrounds)	External noise level 65 dB
Passive recreation areas (such as outdoor grounds used for teaching, outdoor cafes or restaurants)	External noise level 60 dB

Note 1: Adopted from the ICNG.

Other noise-sensitive businesses require separate specific noise goals and it is suggested in the ICNG that the internal construction noise levels at these premises are to be referenced to the 'maximum' internal levels presented in AS 2107. Recommended 'maximum' internal noise levels from AS 2107 are reproduced in **Table 4** for other sensitive receiver types.

However, the ICNG and AS 2107 do not provide specific criteria for childcare centres. Childcare centres generally have internal play areas and sleep areas. The Association of Australian Acoustical Consultants (AAAC) Technical Guideline on Child Care Centre Noise Assessments provides criteria for these land uses. Based on this guideline an $L_{Aeq\ (1hour)}$ of 55 dBA for external play areas and $L_{Aeq\ (1hour)}$ of 40 dBA for indoor play areas and sleeping areas would be adopted.

Table 4 AS 2107 Recommended Maximum Internal Noise Levels

Land Use	Time Period	AS 2107 Classification	Recommended "Maximum" Internal LAeq (dBA)
Hotel	Daytime & Evening	Bars and Lounges	50
	Night-time	Sleeping Areas: - Hotels near major roads	40
Café	When in use	Coffee bar	50
Bar/Restaurant	When in use	Bars and Lounges / Restaurant	50
Library	When in use	Reading Areas	45
Recording Studio	When in use	Music Recording Studios	25
Theatre / Auditorium	When in use	Drama Theatres	30

5.3.2. Commercial and Industrial Premises

Due to the broad range of sensitivities that commercial or industrial land can have to noise from construction, the process of defining management levels is separated into three categories. The external noise levels would be assessed at the most-affected occupied point of the premises:

- Industrial premises (external): 75 dB $L_{Aeq(15minute)}$
- Offices, retail outlets (external): 70 dB $L_{Aeq(15minute)}$
- Other businesses that may be very sensitive to noise, where the noise level is project specific as discussed below

Examples of other noise-sensitive businesses are theatres, studios and child care centres. The proponent would undertake a special investigation to determine suitable noise levels on a project-by-project basis; the recommended internal noise levels presented in Table 1 of AS 2107 "*Acoustics - Recommended design sound levels and reverberation times for building interiors"* (Standards Australia 2000) may assist in determining relevant noise levels; however, an acoustical consultant would be engaged in order to determine corresponding external noise levels based on the published internal noise levels. The proponent would assess construction noise levels for the project, and consult with occupants of commercial and industrial premises prior to lodging an application where required. During construction, the proponent would regularly update the occupants of the commercial and industrial premises regarding noise levels and hours of work.

5.4. Ground-Borne Vibration

The effects of vibration in buildings can be divided into three main categories; those in which the occupants or users of the building are inconvenienced or possibly disturbed, those where the building contents may be affected and those in which the integrity of the building or the structure itself may be prejudiced.

5.4.1. Human Comfort Vibration

The DECCW's "Assessing Vibration: a technical guideline" dated February 2006 (DEC, 2006) recommends the use of BS 6472-1992 for the purpose of assessing vibration in relation to human comfort.

British Standard 6472-1992 "*Guide to evaluation of human exposure to vibration in building*" nominates guideline values for various categories of disturbance, the most stringent of which are the levels of building vibration associated with a "low probability of adverse comment" from occupants.

BS 6472-1992 provides guideline values for continuous, transient and intermittent events that are based on a Vibration Dose Value (VDV), rather than a continuous vibration level. The vibration dose value is dependant upon the level and duration of the short term vibration event, as well as the number of events occurring during the daytime or night-time period.

The vibration dose values recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected are presented in **Table 5**.

Table 5: Vibration Dose Value Ranges which Might Result in Various Probabilities of Adverse Comment within Residential Buildings

Place and Time	Low Probability of Adverse Comment ($m/s^{1.75}$)	Adverse Comment Possible ($m/s^{1.75}$)	Adverse Comment Probable ($m/s^{1.75}$)
Residential buildings 16 hr day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Note: For offices and workshops, multiplying factors of 2 and 4 respectively would be applied to the above vibration dose value ranges for a 16 hr day.

5.4.2. Structural Damage Vibration

Most commonly specified 'safe' structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure.

In terms of the most recent relevant vibration damage goals, Australian Standard AS 2187: Part 2-2006 'Explosives - Storage and Use - Part 2: Use of Explosives' recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 'Evaluation and measurement for vibration in buildings Part 2' as they "are applicable to Australian conditions".

The Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

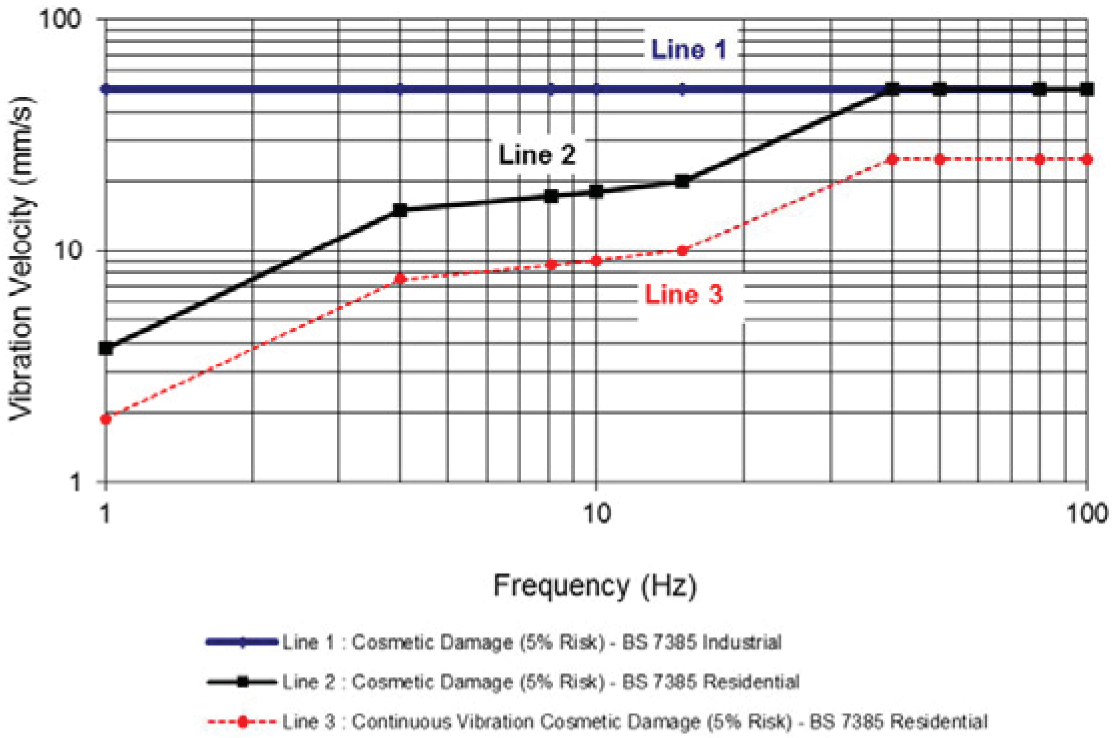
5.4.3. Cosmetic Damage Vibration

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in **Table 6** and graphically in **Figure 1**.

Table 6: Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Figure 1: Graph of Transient Vibration Guide Values for Cosmetic Damage



The Standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in **Table 6**, and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the Standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in **Table 6** would not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS2187 specifies that vibration measured would be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) would be compared with the guidance curves presented in **Figure 1**.

It is noteworthy that extra to the guide values nominated in **Table 6**, the standard states that:

> *"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Also that:

> *"A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."*

5.5. General Vibration Screening Criterion

The Standard states that the guide values in **Table 6** relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

Where the dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in **Table 6** may need to be reduced by up to 50%.

Note: rockbreaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (eg residences) and it may therefore be appropriate to reduce the transient values by 50%.

Therefore for most construction activities involving intermittent vibration sources such as rockbreakers, piling rigs, vibratory rollers, excavators and the like, the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range). On this basis, a conservative vibration damage screening level per receiver type is given below:

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

At locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity), a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level.

5.6. Guidelines for Vibration Sensitive and Special Structures

5.6.1. Heritage

Heritage buildings and structures would be assessed as per the screening criteria in **Section 5.5** as they should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound. If a heritage building or structure is found to be structurally unsound (following inspection) a more conservative cosmetic damage criteria of 2.5 mm/s peak component particle velocity (from DIN 4150) would be considered.

5.6.2. Sensitive Scientific and Medical Equipment

Some scientific equipment (eg electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort.

Where it has been identified that vibration sensitive scientific and/or medical instruments are likely to be in use inside the premises of an identified vibration sensitive receiver, objectives for the satisfactory operation of the instrument would be sourced from manufacturer's data. Where manufacturer's data is not available, generic vibration criterion (VC) curves as published by the Society of Photo-Optical Instrumentation Engineers (Colin G. Gordon - 28 September 1999) may be adopted as vibration goals. These generic VC curves are presented below in **Table 7** and **Figure 2**.

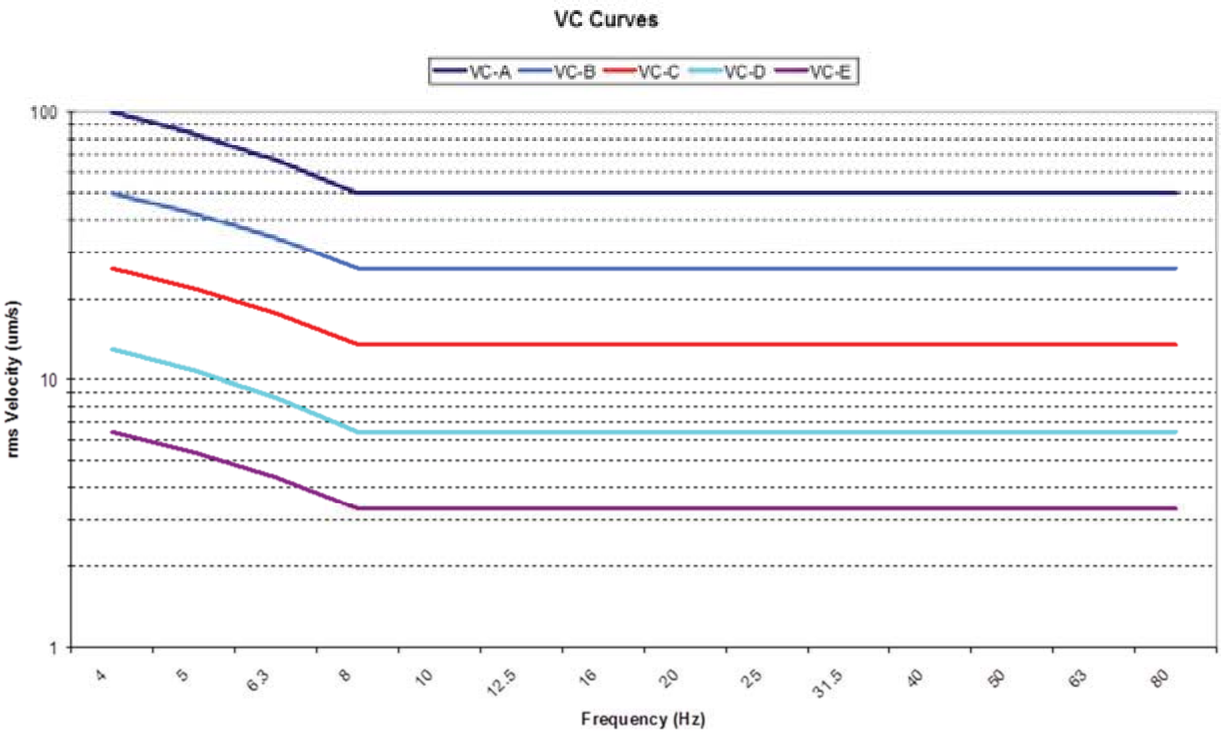
Table 7: Application and Interpretation of the Generic Vibration Criterion (VC) Curves (as shown in Figure 2)

Criterion Curve	Max Level (µm/sec, rms)[1]	Detail Size (microns)[2]	Description of Use
VC-A	50	8	Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc.
VC-B	25	3	An appropriate standard for optical microscopes to 1000X, inspection and lithography equipment (including steppers) to 3 micron line widths.
VC-C	12.5	1	A good standard for most lithography and inspection equipment to 1 micron detail size.
VC-D	6	0.3	Suitable in most instances for the most demanding equipment including electron microscopes (TEMs and SEMs) and E-Beam systems, operating to the limits of their capability.
VC-E	3	0.1	A difficult criterion to achieve in most instances. Assumed to be adequate for the most demanding of sensitive systems including long path, laser-based, small target systems and other systems requiring extraordinary dynamic stability.

Note 1: As measured in one-third octave bands of frequency over the frequency range 8 to 100 Hz.

Note 2: The detail size refers to the line widths for microelectronics fabrication, the particle (cell) size for medical and pharmaceutical research, etc. The values given take into account the observation requirements of many items depend upon the detail size of the process.

Figure 2: Vibration Criterion (VC) Curves



5.6.3. Other Vibration Sensitive Structures and Utilities

Where structures and utilities are encountered which may be considered to be particularly sensitive to vibration, a vibration goal which is more stringent than structural damage goals presented in Section 5.4 may need to be adopted. Examples of such structures and utilities include:

- Tunnels
- Gas pipelines
- Fibre optic cables

Specific vibration goals would be determined on a case-by-case basis. An acoustic consultant would be engaged by the construction contractor and would liaise with the structure or utility's owner in order to determine acceptable vibration levels.

5.7. Vibration and Overpressure from Blasting

The DECCW's ICNG recommends that vibration and overpressure from blasting be assessed against the levels presented in the Australian and New Zealand Environment Council's (ANZECC) Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC, 1990).

The criteria set by this standard are targeted at operations that occur for long periods of time such as those at mining sites and hence are targeted at protecting human comfort vibration levels. As a result the vibration levels are conservative and can introduce unnecessary constraints when applied to construction projects which typically occur for much shorter time periods. Recent NSW infrastructure project approvals have recognised the restrictive nature of these blasting criteria when applied to construction projects and have therefore allowed the following vibration and overpressure limits:

- Vibration (PPV): 25 mm/s
- Overpressure: 125 dBL

These upper limits are deemed acceptable where the proponent has a written agreement with the relevant landowner to exceed the criteria and the Secretary has approved the terms of the written agreement. These upper limits to vibration and overpressure are intended to target the protection of building structures from cosmetic damage rather than human comfort criteria as construction works are considered short-term.

5.8. Ground-Borne (Regenerated) Noise

Ground-borne (regenerated) noise is noise generated by vibration transmitted through the ground into a structure. Ground-borne noise caused, for example by underground works such as tunnelling, can be more noticeable than airborne noise. The following ground-borne noise levels for residences are nominated in the ICNG and indicate when management actions would be implemented. These levels recognise the temporary nature of construction and are only applicable when ground-borne noise levels are higher than airborne noise levels.

The ground-borne noise management levels are given below:

- Day (7.00 am to 6.00pm)
  Internal Residential: 45 dB $L_{Aeq(15minute)}$
  Internal Commercial: 50 dB $L_{Aeq(15minute)}$

- Evening (6.00 pm to 10.00 pm)
  Internal Residential: 40 dB $L_{Aeq(15minute)}$
- Night-time (10.00 pm to 7.00 am)
  Internal Residential: 35 dB $L_{Aeq(15minute)}$

The daytime criteria are applicable to both residential and commercial receivers, whereas the evening and night-time criteria are only applicable to residential receivers.

The internal noise levels are to be assessed at the centre of the most-affected habitable room. For a limited number of discrete, ongoing ground-borne noise events, such as drilling or rock-hammering, The L_{Amax} noise descriptor using a slow response on the sound level meter may be better than the L_{Aeq} noise descriptor (15 min) in describing the noise impacts. The level of mitigation of ground-borne noise would depend on the extent of impacts and also on the scale and duration of works. Any restriction on the days when construction work is allowed would take into account whether the community:

- Has identified times of day when they are more sensitive to noise (for example Sundays or public holidays).
- Is prepared to accept a longer construction duration in exchange for days of respite.

5.9. Traffic Noise Assessment Goals

When trucks and other vehicles are operating within the boundaries of the various construction sites, road vehicle noise contributions are included in the overall predicted $L_{Aeq(15minute)}$ construction site noise emissions. When construction related traffic moves onto the public road network a different noise assessment methodology is appropriate, as vehicle movements would be regarded as 'additional road traffic' rather than as part of the construction site.

The ICNG does not provide specific guidance in relation to acceptable noise levels associated with construction traffic. For assessment purposes, guidance is taken from the RNP.

One of the objectives of the RNP is to apply relevant permissible noise increase criteria to protect sensitive receivers against excessive decreases in amenity as the result of a proposal. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

On this basis, construction traffic NMLs set at 2 dB above the existing road traffic noise levels during the daytime and night-time periods are considered appropriate to identify the onset of potential noise impacts. Where the road traffic noise levels are predicted to increase by more than 2 dB as a result of construction traffic, consideration would be given to applying feasible and reasonable noise mitigation measures to reduce the potential noise impacts and preserve acoustic amenity.

In considering feasible and reasonable mitigation measures where the relevant noise increase is greater than 2 dB, consideration would also be given to the actual noise levels associated with construction traffic and whether or not these levels comply with the following road traffic noise criteria in the RNP:

- 60 dB $L_{Aeq(15hour)}$ day and 55 dB $L_{Aeq(9hour)}$ night for existing freeway/ arterial/ sub-arterial roads.
- 55 dB $L_{Aeq(1hour)}$ day and 50 dB $L_{Aeq(1hour)}$ night for existing local roads.

5.9.1. Sleep Disturbance and Maximum Noise Events

In addition to the current legislative guidance on potential sleep disturbance outlined in Section 5.10 the RNP refers to Practice Note 3 of the ENMM for specific impacts from road traffic. The ENMM recommends an evaluation of the number and distribution of night-time passby events where the L_{AFmax} - $L_{Aeq(1hour)}$ difference is greater than 15 dB, and the maximum noise level of that event is greater than 65 dB L_{Amax}.

On the basis of the current guidance:

- External sleep disturbance screening criterion of RBL + 15 dB
- External sleep disturbance criterion of 65 dB L_{Amax} (assuming open windows).

5.10. Sleep Disturbance and Maximum Noise Level Events

The DECCW's ECRTN and the Road and Traffic Authority's (RTA's) *'Environmental Noise Management Manual'* (ENMM) provide guidance as to the likelihood of sleep disturbance resulting from maximum noise level events (mainly associated with heavy vehicle movements). The ECRTN points out the following:

"There are no universally accepted criteria governing the likelihood of sleep disturbance. In other words, at the current level of understanding, it is not possible to establish absolute noise levels that correlate to levels of sleep disturbance (for all or even a majority of people)."

Notwithstanding the ECRTN/ENMM suggests that:

- Maximum internal noise levels below 50 dB to 55 dB L_{Amax} are unlikely to cause awakening reactions.
- One or two events per night, with maximum internal noise levels of 65 dB to 70 dB L_{Amax}, are not likely to affect health and wellbeing significantly.
- At locations where road traffic is continuous rather than intermittent, the $L_{Aeq(9hour)}$ target noise level should sufficiently account for sleep disturbance impacts.
- Where the emergence of L_{Amax} noise levels over the ambient L_{Aeq} noise level is greater than 15 dB, the L_{Aeq} criterion may not sufficiently account for sleep disturbance impacts.

A maximum noise event can be defined as any passby for which the difference in the L_{Amax} and $L_{Aeq(1Hour)}$ noise levels is greater than 15 dB. Furthermore, the ECRTN recommends that the assessment of sleep disturbance should include a consideration of the maximum noise level exceedances occurring during the night-time period and the emergence of these exceedances above the ambient noise level.

6. CONSTRUCTION NOISE & VIBRATION ASSESSMENT METHODOLOGY

6.1. Overview

Program and site constraints require that 24 hour working would most likely be required at all metro construction sites for a significant proportion of the total construction period. In particular, noisy activities such as:

- Excavation of tunnel and station caverns by Tunnel Boring Machines (TBMs) and roadheaders would be required over a 24 hour day, 6 days a week. Note that TBMs typically require routine maintenance of equipment on the 7th day.

- Bulk excavation of station entry and ventilation shafts by rockbreaker / blasting (or equivalent methodology), raise boring, line drilling and milling head would be required 24 hours a day for 7 days a week.
- Truck movements would be required 24 hours a day for 7 days a week.

6.2. Expected Construction Activities

Table 8 presents the construction activities which are likely to be undertaken during the construction of all Sydney Metro projects, together with typical plant and equipment required to execute each activity.

Table 8: Construction Activities and Typical Plant and Equipment

Activity	Significant Noise and Vibration Generating Plant and Equipment
Demolition	Excavator Dump Trucks Rockbreaker Jackhammer
General Earthworks and site establishment	Excavator Dumps Trucks Delivery Trucks
Spoil Removal	Excavator Dump Trucks
Shaft Excavation	Rockbreakers Penetrating Cone Fracture (PCF) Blasting Jackhammer
Station Cavern Excavation	Roadheaders
Tunnelling	Tunnel Boring Machine (TBM) Roadheaders
Cross passages	Rock breakers Roadheaders
Building/Facility Construction	Standard Construction Techniques Including: - Cranes - Delivery Trucks - Hand Tools/Hand Held Power Tools
Demolition	Excavator Dump Trucks Rockbreaker Jackhammer
General Earthworks and site establishment	Excavator Dumps Trucks Delivery Trucks
Spoil Removal	Excavator Dump Trucks
Shaft Excavation	Rockbreakers Penetrating Cone Fracture (PCF) Blasting Jackhammer

6.3. Noise and Vibration Sensitive Receivers

The sensitivity of occupants to noise and vibration varies according to the nature of the occupancy and the activities performed within the affected premises. For example, recording studios are more sensitive to vibration and ground borne noise than residential premises, which in turn are more sensitive than typical commercial premises.

Specific noise and vibration sensitive receivers (NSRs) relevant to individual construction sites would be identified and addressed in the Environmental Assessment of each Sydney Metro project. Each receiver would be identified as falling into one of the following categories:

- Commercial
- Educational
- Industrial
- Mixed residential/commercial
- Residential
- Residential occupied by shift workers
- Place of Worship
- Medical facilities
- Other sensitive receivers

6.4. General Assessment Procedure

All assessments must be quantitative as per the procedure given in the ICNG. If the assessment is being carried out for the environmental impact assessment documentation (eg EIS) it will be based on a concept design and construction scenarios for the project (usually prepared by a technical advisor and/or planning consultant). If the assessment is being undertaken prior to construction (eg CNIS) it will be based on a more detailed design and actual construction scenario (usually prepared by the design and/or construction contractors).

Constructions Noise Impact Statements (CNIS) are to be developed to assess the potential impact of noise at NSRs as a result of a Sydney Metro project's construction activities prior to the commencement of construction components.

In order to develop accurate and comprehensive CNIS reports for work components associated with the project, specific detail of the construction methodology, including the size and type of equipment is required. Detailed design, construction and engineering solutions are progressively developed and applied throughout the life-span of the project. Consequently, CNIS reports that cover the key construction activities/components are to be developed to reflect the progressive nature of design and construction of the project. There are to be two (2) different types of CNIS report to be developed throughout the project:

- General Construction Activity CNIS for construction scenarios that are consistently the same and progressively move along the project alignment eg tunnelling, retaining walls.
- Location Specific CNIS for construction scenarios that are specific to a location. Where works are required to be undertaken outside of standard construction hours, Out of Hours Work (OOHW) assessments will be included in CNIS or a new CNIS

developed in support of all applicable variations to the project Environment Protection Licence (EPL).

For all CNIS reports the noise impacts are to be assessed based on construction scenarios. A construction scenario relating to noise impact is essentially a construction activity with is made up of the required plant and equipment. A number of construction scenarios will make up any one CNIS report. In undertaking an assessment of the noise impact from a construction scenario(s) including the development of CNIS report, the following steps are to be taken:

- Identify all noise and/or vibration sensitive receivers (NSRs) which may be affected by the project.
- Conduct background noise monitoring at representative NSRs to determine the rating background noise levels (RBLs) in accordance with the procedures presented in the NSW Industrial Noise Policy, where RBLs have not been established in previous project stages.
- Determine the appropriate noise and vibration management levels of each NSR.
- Determine the source noise levels (Sound Power Levels) of each noise generating plant and equipment item required to undertake the construction scenario. Note: Sound Power Levels for each plant and equipment would be less than the maximum allowable levels found in Table 11 and Table 12.
- Clearly indicate which mitigation measures identified in Section 7 have been/are to be incorporated into the noise assessment. Noise mitigation measures to be implemented will vary for reasons such as safety and space constraints, these are to be identified and the calculations adjusted accordingly.
- For Location Specific construction scenarios and where applicable for Generic scenarios, include the effects of noise shielding provided by site offices, residential fences, noise barriers or natural topographic features.
- Where applicable include the effects of noise reflections and ground attenuation.
- On the basis of the duration of each activity (over a typical “worst case” 15-minute period), determine whether any correction between the L_{Amax} and the L_{Aeq} is required.
- Calculate the L_{Aeq} noise or range of levels from construction scenarios at sensitive receiver groups, with the use of noise contour maps where appropriate and/or at 10 m, 25 m, 50 m, 75 m,100 m and 200 m for more general construction activities.
- Compare these against the goals identified for each NSR and identify predicted exceedances.
- For night-time activities, calculate the $L_{A1(60second)}$ noise levels and compare with the DECCW’s RBL + 15 dB sleep disturbance screening criterion. On the basis of the ambient noise environment during the night-time period, the predicted L_{A1} noise levels and the number of expected L_{A1} noise events would be assessed. From this assessment determine the likelihood of potential sleep disturbance. Note: the L_{Amax} noise level can be used to estimate the L_{A1} noise level.
- On completion of all CNIS reports for the subjective classification of the noise impact is to be evaluated and documented as:
  - Lower Impact
  - Moderate Impact

- o High Impact

The classifications are to be determined on a case-by-case basis with consideration of the following points. These are guidelines for classifications only and subjective due to the number of variances within any construction scenario. An objective evaluation is to be applied to all construction scenarios.

- The location of the works in relation to NSRs with consideration of noise attenuation features such as noise barriers including topographical features (earth-mounds), buildings, dividing fences etc (distance of works from sensitive receiver(s)).
- The type and sensitivity of the NSRs:
  - o Lower Impact: eg Commercial buildings/ Scattered Residential (low density)
  - o Moderate Impact: eg Standard residential (typical density)
  - o High Impact: eg Residential home for the elderly/high density unit blocks/persistent complainers/residents deemed to have “construction noise fatigue”.
- The extent of noise exceedance above Noise Management Level.
- The likelihood for potential sleep disturbance RBL + 15 dB.
- The type of and intensity of noise emitted from works (ie tonal or impulsive):
  - o Lower Impact: No high noise and/or vibration intensive activities
  - o Moderate Impact: Short/intermittent high noise and/or vibration intensive activities
  - o High Impact: Prolonged high noise and/or vibration intensive activities.
- The duration of any OOHW required.
- The time frames for any OOHW:
  - o Lower Impact: 6.00 pm till 10.00 pm weekdays 1.00 pm till 10.00pm Saturdays

    8.00 am till 6.00 pm Sundays or Public Holidays
  - o Moderate Impact: 10.00 pm to 7.00 am Weekday Nights 10.00 pm to 8.00 am Saturdays
  - o High Impact: 6.00 pm to 7.00 am Sundays and Public Holidays.
- As a result of noise classification and/or the noise level exceedances at sensitive receivers provided by the CNIS reports, appropriate reasonable and feasible noise mitigation is to be adopted and implemented. For sites where works are predicted to significantly exceed noise goals and impact on receivers for a significant period of time, additional reasonable and feasible noise mitigation measures such as those outlined in Section 7 would be considered if practical to reduce the noise levels and impact on sensitive receivers.

6.5. Ground-Borne (Regenerated) Noise

Ground-borne noise as a result of construction activities is usually associated with tunnelling projects where equipment such as tunnel boring machines, road headers, rock hammers and drilling rigs are operated underground. It is therefore anticipated that ground-borne noise may be an issue during the construction of Sydney Metro projects.

If ground-borne noise is anticipated as a result of construction activities, a CNIS report, specifically in relation to the assessment of ground-borne construction noise would be undertaken.

In undertaking a CNIS report for ground-borne construction noise the following steps are to be taken:

- Determine the location of each plant and equipment item in relation to each receiver.
- On the basis of ground-borne noise versus distance prediction algorithms for each plant item, determine the level of ground-borne noise at each building location. For highly sensitive building occupancies, such as recording studios, the assessment may need to incorporate the acoustic properties of the building space and the structural response of the building. This is to be determined by a qualified acoustic consultant, should ground-borne noise be a potential issue.
- Include the effect of all relevant standard mitigation measures as part of the construction scenario.
- Calculate the $L_{Aeq(15minute)}$ noise levels from the proposed construction actives at each receiver and compare these to the ground-borne noise management levels.

6.6. Ground-Borne Vibration

Vibration as a result of construction activities is usually associated with tunnelling projects where equipment such as tunnel boring machines, road headers, rock hammers and drilling rigs are operated underground. It is therefore anticipated that ground-borne vibration may be an issue during the construction of Sydney Metro projects.

If vibration impacts are anticipated as a result of construction activities, a CNIS report, specifically in relation to the assessment of construction vibration would be undertaken.

In undertaking a CNIS report for ground-borne construction vibration the following steps are to be taken:

- Determine the location of each plant and equipment item in relation to each receiver.
- On the basis of ground-borne vibration versus distance prediction algorithms for each plant item, determine the level of ground-borne vibration at each building location. For highly sensitive building occupancies, such as recording studios, the assessment may need to incorporate the vibration properties of the building space and the structural response of the building. This is to be determined by a qualified acoustic consultant, should ground-borne vibration be a potential issue.
- Include the effect of all relevant standard mitigation measures as part of the construction scenario.

Calculate the vibration levels from the proposed construction actives at each receiver and compare these to the ground-borne vibration criteria.

6.7. Vibration and Overpressure from Blasting

Vibration and overpressure as a result of construction activities is usually associated with tunnelling projects where blasting is required. If this construction is implemented then vibration and overpressure may be an issue during the construction of Sydney Metro projects.

If vibration and overpressure impacts are anticipated as a result of construction blasting, a CNIS report, specifically in relation to the assessment of construction blasting would be undertaken.

In undertaking a CNIS report for blasting vibration and overpressure the following steps are to be taken:

- Determine the location of blast charge in relation to each receiver.
- On the basis of vibration / overpressure versus distance prediction algorithms for blasting determine the level of vibration / overpressure at each receiver (building) location.
- Include the effect of all relevant standard mitigation measures as part of the construction scenario.

Calculate the vibration and overpressure levels from the proposed blasting actives at each receiver and compare these to the blasting criteria.

7. STANDARD NOISE AND VIBRATION MITIGATION MEASURES

7.1. Minimum Requirements

This section sets out the standard construction noise and vibration mitigation measures to be implemented on all Sydney Metro projects and delivered via relevant procedures, systems, environmental assessment, construction environmental management and all relevant contract documentation.

For all Sydney Metro construction projects, the standard mitigation measures in **Table 9** shall be applied by default in order to minimise the potential noise and vibration impacts at the surrounding Noise Sensitive Receivers. Additional information in relation to specific mitigation measures, the assessment process and relevant objectives are provided in **Section 8**.

During the preparation of the environmental assessment documentation, a construction noise and vibration assessment would be undertaken. This includes monitoring requirements in order to validate the modelling assumptions and confirm that noise levels from individual plant and equipment items are not excessive. This section provides guidance in relation to standard monitoring and survey requirements that are expected for Sydney Metro construction projects.

7.1.1. Management Strategies during Construction

- Construction hours would be in accordance with the ICNG, project approvals and the EPL, except where otherwise specified in an approved noise management plan.
- When working adjacent to schools, medical facilities and childcare centres, particularly noisy activities would be scheduled outside normal working hours, where feasible and reasonable.
- When working adjacent to churches and places of worship particularly noisy activities would be scheduled outside services, where feasible and reasonable.
- Avoiding the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers will result in reduced noise emissions.

- Where feasible and reasonable, the offset distance between noisy plant items and nearby noise sensitive receivers would be as great as possible.
- Regular compliance checks on the noise emissions of all plant and machinery used for the project would indicate whether noise emissions from plant items were higher than predicted. This also identifies defective silencing equipment on the items of plant.
- Ongoing noise monitoring during construction at sensitive receivers during critical periods (ie times when noise emissions are expected to be at their highest - eg piling and hammering) to identify and assist in managing high risk noise events.
- Where feasible and reasonable heavy vehicle movements would be limited to daytime hours.
- The implementation of procedures to maximise the night-time onsite spoil storage capacity where spoil is produced between the hours of 10.00 pm and 7.00 am.

7.1.2. Site Induction for all Employees, Contractors and Subcontractors

The site induction would include the following as a minimum:

- All relevant project specific and standard noise and vibration mitigation measures
- Relevant licence and approval conditions
- Permissible hours of work
- Any limitations on high noise generating activities
- Location of nearest sensitive receivers
- Construction employee parking areas
- Designated loading/unloading areas and procedures
- Site opening/closing times (including deliveries)
- Environmental incident reporting and management procedures

7.1.3. Source Noise Control Strategies

- Engines and exhausts are typically the dominant noise sources on mobile plant such as cranes, graders, excavators, heavy vehicles, etc. In order to minimise noise emissions, residential grade mufflers would be fitted on all mobile plant utilised on Sydney Metro construction projects.
- The use of damped hammers is recommended such as the ‘City’ model Rammer hammers. These reduce the ‘ringing’ of the rockpick, cylinder and excavator arm that is commonly associated with rockbreaking works. Approximately 10 dB attenuation can be achieved compared to undamped hammers of the same size.
- Regular maintenance of all plant and machinery used for the project will assist in minimising noise emissions, including the reporting of the results.
- Acoustic enclosure of plant items, if required, as identified during compliance monitoring.
- Air brake silencers would be correctly installed and fully operational for any heavy vehicle that approaches and uses any Sydney Metro construction site.
- Non-tonal reversing alarms would be used for all permanent mobile plant operating on Sydney Metro construction projects. Whilst the use of non-tonal reversing

alarms is suggested to ensure noise impacts are minimised, it is noted that OH&S requirements must also be fully satisfied.

7.1.4. Noise Barrier Control Strategies

Temporary noise barriers are recommended between the noise sources and nearby potentially affected noise sensitive receivers, wherever feasible. Typically, 5 dB to 15 dB attenuation can be achieved with a well-constructed barrier.

7.1.5. Acoustic Enclosures

Where significant noise impacts are predicted and/or long periods of construction works are planned, acoustic enclosures can be used as an effective mitigation method. Acoustic enclosures act to contain the sources of noise, whilst also providing the benefit of screening the construction site from view. An enclosure with no openings would be expected to provide attenuation the order of 20 dB.

7.1.6. Vibration Control Strategies

Attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels satisfy the criteria for that vibration generating activity. Where there is potential for exceedances of the criteria further vibration site law investigations would be undertaken to determine the site-specific safe working distances for that vibration generating activity. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

7.1.7. Community Consultation

Active community consultation and the maintenance of positive, cooperative relationships with schools, local residents and building owners and occupiers assists in managing impacts from noisier operations and in alleviating concerns and thereby minimising disturbance and complaint. This includes, for example:

- Periodic notification or work activities and progress (eg regular letterbox drops, e-consult)
- Specific notification (letter-box drop) prior to especially noisy activities
- Comprehensive website information
- Project information and construction response telephone line
- Email distribution list

7.2. Summary of the Standard Mitigation Measures

The actions set out in **Table 9** must be implemented on all Sydney Metro construction projects.

Table 9: Standard Mitigation Measures to Reduce Construction Noise and Vibration

Action required	Applies to	Details
Management Measures		
Implementation of any project specific mitigation measures required	Airborne noise Ground-borne noise and vibration	In addition to the measures set out in this table, any *project specific* mitigation measures identified in the environmental assessment documentation (eg EA, REF, submissions or representations report) or approval or licence conditions must be implemented.
Implement community consultation measures	Airborne noise Ground-borne noise and vibration	Periodic Notification (monthly letterbox drop)[1] Website Project information and construction response telephone line Email distribution list Place Managers
Register of Noise Sensitive Receivers	Airborne noise Ground-borne noise and vibration	A register of all noise and vibration sensitive receivers (NSRs) would be kept on site. The register would include the following details for each NSR: • Address of receiver • Category of receiver (eg Residential, Commercial etc.) • Contact name and phone number
Site inductions	Airborne noise Ground-borne noise and 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 high noise generating activities • 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 and vibration	A noise monitoring program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.

[1] Detailing all upcoming construction activities at least 14 days prior to commencement of relevant works

Action required	Applies to	Details
Attended vibration measurements	Ground-borne vibration	Attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels satisfy the criteria for that vibration generating activity. Where there is potential for exceedances of the criteria further vibration site law investigations would be undertaken to determine the site-specific safe working distances for that vibration generating activity. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the applicable safe-working distances.
Source Controls		
Construction hours and scheduling	Airborne noise Ground-borne noise and vibration	Where feasible and reasonable, construction would be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels would be scheduled during less sensitive time periods.
Construction respite period	Ground-borne noise and vibration Airborne noise	High noise and vibration generating activities[2] may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block[3].
Equipment selection	Airborne noise Ground-borne noise and vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. 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 Levels compliant with the criteria in **Table 11**.
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 criteria in **Table 11**.
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.
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.

[2] Includes jack and rock hammering, sheet and pile driving, rock breaking and vibratory rolling.

[3] “Continuous” includes any period during which there is less than a 60 minutes respite between ceasing and recommencing any of the work.

Action required	Applies to	Details
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 NSRs Select site access points and roads as far as possible away from NSRs Dedicated loading/unloading areas to be shielded if close to NSRs Delivery vehicles to be fitted with straps rather than chains for unloading, wherever feasible and reasonable
Path Controls		
Shield stationary noise sources such as pumps, compressors, fans etc	Airborne noise	Stationary noise sources would 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.

Table 10: Minimum Requirements for Construction Methods

Method	Minimum Requirements
Excavator	Ensure that the Sound Power Levels given in **Table 11** have been met.
Truck	Ensure that the Sound Power Levels given in **Table 11** have been met.
Rockbreakers and jackhammers	Ensure that the Sound Power Levels given in Error! Reference source not found. have been met. Noise and vibration monitoring would be conducted at the nearest identified NSR where exceedances of the criteria have been predicted.
PCF	Where it has been predicted that vibration / regenerated noise is likely to be in excess of the nominated goals, specific notification would be given to all NSRs a minimum of 2 weeks prior to a shot being fired. Vibration and overpressure monitoring would be conducted at the nearest identified NSR.
Blasting	Where it has been predicted that vibration / overpressure is likely to be in excess of the nominated goals, specific notification would be given to all NSRs a minimum of 2 weeks prior to a shot being fired. Vibration and overpressure monitoring would be conducted at the nearest identified NSR.
TBM	Noise and vibration monitoring would be conducted at the nearest identified NSR where levels are expected to exceed the relevant noise and vibration goals.
Roadheaders	Noise and vibration monitoring would be conducted at the nearest identified NSR where levels are expected to exceed the relevant noise and vibration goals.

7.3. Maximum Allowable Plant Sound Power Levels

Plant or equipment operating on Sydney Metro project construction sites shall have an operating sound power level (SWL) which is no higher than the corresponding SWL presented in **Table 11**. The SWLs presented in **Table 11** have been compiled from a selection of field measurements conducted between 2004 and 2008 of plant and equipment operating on large construction projects throughout NSW and are therefore considered to representative of plant and equipment SWLs which are readily achieved by current plant and equipment normally used in the construction industry.

Plant and equipment with SWLs higher than those presented in **Table 11** would be deemed to be emitting an excessive level of noise and would not be permitted to operate Sydney Metro project construction sites.

Table 11: Maximum Allowable Sound Power Levels for Construction Equipment

Equipment	Maximum Allowable Sound Power Level (dB) LAmax	Maximum Allowable Sound Pressure Level (dB) LAmax at 7 m
Excavator Hammer	118	93
Excavator (approx. 3 tonne)	90	65
Excavator (approx. 6 tonne)	95	70
Excavator (approx. 10 tonne)	100	75
Excavator (approx. 20 tonne)	105	80
Excavator (approx. 30 tonne)	110	85
Excavator (approx. 40 tonne)	115	90
Skidsteer Loaders (approx. 1/2 tonne)	107	82
Skidsteer Loaders (approx. 1 tonne)	110	85
Dozer (tracking) - equiv. CAT D8	118	93
Dozer (tracking) - equiv. CAT D9	120	95
Dozer (tracking) - equiv. CAT D10	121	96
Backhoe/FE Loader	111	86
Dump Truck (approx. 15 tonne)	108	83
Concrete Truck	112	87
Concrete Pump	109	84
Concrete Vibrator	105	80
Bored Piling Rig	110	85
Scraper	110	85
Grader	110	85
Vibratory Roller (approx. 10 tonne)	114	89
Vibratory Pile Driver	121	96
Impact Piling Rig	134	109
Compressor (approx. 600 CFM)	100	75
Compressor (approx. 1500 CFM)	105	80
Concrete Saw	118	93
Jackhammer	113	88

Equipment	Maximum Allowable Sound Power Level (dB) LAmax	Maximum Allowable Sound Pressure Level (dB) LAmax at 7 m
Generator	104	79
Lighting Tower	80	55
Flood Lights	90	65
Cherry Picker	102	77
Mobile Crane	110	85

Where an item of construction equipment is not listed in **Table 11**, generic sound power levels presented in **Table 12** may be adopted.

Table 12: Generic Equipment or System Sound Power Level Limit[1]

Equipment	Maximum Allowable Sound Power Level (dB) LAmax	Maximum Allowable Sound Pressure Level (dB) LAmax at 7 m
Motorised (<25kW)	90	65
Motorised (<50kW)	95	70
Motorised (<100kW)	100	75
Motorised (<200kW)	105	80
Motorised (>200kW)	110	85
All other Auxiliary Equipment or Systems	90	65

Note 1: Sound Power Levels in dBA relative to 10 pW.

7.4. Auditing and Monitoring

All items of plant would have noise audits conducted in accordance with the procedures outlined in **Section 9** of this strategy upon arrival at a Sydney Metro construction site and at 6 month intervals thereafter.

Where it has been identified within this strategy that noise and/or vibration monitoring is required at the nearest sensitive receiver; however, the nearest sensitive receiver has refused monitoring at their property, monitoring would be undertaken at the near point to that receiver within the site boundary or at another suitable location determined by an acoustic consultant.

8. ADDITIONAL NOISE AND VIBRATION MITIGATION MEASURES

8.1. Overview

The implementation of the standard management measures, compliance with maximum sound power levels for plant and equipment, construction hour management and standard community consultation measures in this Strategy should significantly reduce the noise and vibration impacts on nearby sensitive receivers.

Nevertheless, due to the highly variable nature of construction activities and the likelihood of work outside the standard construction hours on Sydney Metro projects, exceedances of the construction noise and vibration management levels are likely to occur.

Where there is a potential exceedance of the construction noise and vibration management levels a number of additional measures to mitigate such exceedances – primarily aimed at pro-active engagement with affected sensitive receivers – would be explored and have been included in this Strategy. The additional mitigation measures to be applied are outlined in **Table 13**.

Table 13: Additional Management Measures

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

8.2. Applying Additional Mitigation Measures

In circumstances where - after application of the standard mitigation measures - the $L_{Aeq(15minute)}$ construction noise and vibration levels are still predicted to exceed the noise or vibration objectives, the relevant Additional Mitigation Measures Matrix (AMMM) (see **Table 14** to **Table 16**) is to be used to determine the additional measures to be implemented. This requirement is supplemental to the basic requirements in the ICNG.

Using the relevant AMMM, the following steps need to be carried out to determine the additional mitigation measures to be implemented:

- Determine the duration (time period) when the work is to be undertaken.
- Determine the level of exceedance.
- From the relevant AMMM table, identify the additional mitigation measures to be implemented (using the abbreviation codes - expanded in **Table 13**).

Table 14: Additional Mitigation Measures Matrix (AMMM) - Airborne Construction Noise

Time Period		Mitigation Measures			
		Predicted $L_{Aeq(15minute)}$ Noise Level Above Background (RBL)			
		0 to 10 dB	10 to 20 dB	20 to 30 dB	> 30 dB
Standard	Mon-Fri (7.00 am - 6.00 pm) Sat (8.00 am - 1.00 pm) Sun/Pub Hol (Nil)	-	-	M, LB,	M, LB
OOHW	Mon-Fri (6.00 pm - 10.00 pm) Sat (1.00 pm - 10.00 pm) Sun/Pub Hol (8.00 am - 6.00 pm)	-	LB	M, LB	M, IB, LB, PC, RO,SN
OOHW	Mon-Fri (10.00 pm - 7.00 am) Sat (10.00 pm - 8.00 am) Sun/Pub Hol (6.00 pm - 7.00 am)	-	M, LB,	M, IB, LB, PC, RO, SN	AA, M, IB, LB, PC, RO, SN

Table 15: AMMM - Ground-borne Construction Noise

Time Period		Mitigation Measures		
		Predicted $L_{Aeq(15minute)}$ Noise Level Exceedance		
		0 to 10 dB	10 to 20 dB	> 20 dB
Standard	Mon-Fri (7.00 am - 6.00 pm) Sat (8.00 am - 1.00 pm) Sun/Pub Hol (Nil)	LB	LB	M, LB, SN,
OOHW	Mon-Fri (6.00 pm - 10.00 pm) Sat (1.00 pm - 10.00 pm) Sun/Pub Hol (8.00 am - 6.00 pm)	LB	M, LB, SN,	M, IB, LB, PC, RO, SN
OOHW	Mon-Fri (10.00 pm - 7.00 am) Sat (10.00 pm - 8.00 am) Sun/Pub Hol (6.00 pm - 7.00 am)	M, LB, SN,	AA, M, IB, LB, PC, RO, SN	AA, M, IB, LB, PC, RO, SN

Table 16: AMMM - Ground-borne Vibration

Time Period		Mitigation Measures
		Predicted Vibration Levels Exceed Maximum Levels
Standard	Mon-Fri (7.00 am - 6.00 pm)	M, LB, RP
	Sat (8.00 am - 1.00 pm)	
	Sun/Pub Hol (Nil)	
OOHW	Mon-Fri (6.00 pm - 10.00 pm)	M, IB, LB, PC, RO, SN
	Sat (1.00 pm - 10.00 pm)	
	Sun/Pub Hol (8.00 am - 6.00 pm)	
OOHW	Mon-Fri (10.00 pm - 7.00 am)	AA, M, IB, LB, PC, RO, SN
	Sat (10.00 pm - 8.00 am)	
	Sun/Pub Hol (6.00 pm - 7.00 am)	

9. MONITORING, AUDITING AND REPORTING

A construction noise and vibration monitoring guideline is included in **Appendix A** and outlines the minimum requirements for contractors undertaking monitoring on the Sydney Metro Project.

9.1. Plant Noise Auditing, Compliance Evaluation and Reporting

In order to compare the noise levels of plant and equipment with the values in Section 7, the following guidelines are recommended:

- Measurements of Sound Pressure Level (SPL) at 7 m (with plant or equipment stationary) shall be undertaken using procedures that are consistent with the requirements of Australian Standard AS2012–1990 Acoustics – Measurement of Airborne Noise Emitted by Earthmoving Machinery and Agricultural Tractors – Stationary Test Condition Part 1: Determination of Compliance with Limits for Exterior Noise.
- Measurements of Sound Power Level (SWL) shall be determined using procedures that are consistent with the requirements of International Standard ISO9614-2 1996 Acoustics – Determination of sound power levels of noise sources using sound intensity - Part 2: Measurement by scanning.
- If measuring the SPL at 7 m of moving plant, compliance measurements would be guided by the requirements of Australian Standard AS2012–1977 Method for Measurement of Airborne Noise From Agricultural Tractors and Earthmoving Machinery.

For all measurements, the plant or equipment under test would be measured while operating under typical operating conditions. If this is not practical, it may be appropriate to conduct a stationary test at high idle.

In the case of an exceedance in sound power levels the item of plant would either be replaced, or the advice of an acoustic consultant would be sought to provide suitable mitigation measures, which may include:

- ensuring all bolts are tightened and no parts are loose
- cleaning and/or lubricating moving parts
- replacing old or worn parts
- implementing additional or upgrading existing muffling devices
- building enclosures around items of stationary plant (eg pumps or generators).

A register of measured sound power levels for each item of plant would be kept for reference where future noise audits are conducted. The register would be reviewed annually in conjunction with this strategy and corresponding revisions made to the Sound Power Levels presented in Section 7 to represent contemporary plant noise emission levels.

9.2. Noise Monitoring

Where a CNIS report has been prepared for a Sydney Metro construction site and it has been predicted that noise levels may be in excess of the nominated construction noise goals at a noise sensitive receiver, noise monitoring would be conducted at:

- the affected receiver; or
- if more than one affected receiver has been identified, at the nearest affected receiver; or
- where the nearest affected receiver refuses noise monitoring on their property, at the near point to that receiver within the site boundary.
- If it can be demonstrated that direct measurement of noise from the construction site is impractical, alternative means of determining construction noise levels may be adopted in accordance with Chapter 11 of the NSW Industrial Noise Policy.

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

9.3. Vibration Monitoring

Where it is anticipated that an item of plant will exceed the cosmetic damage criteria given in Section **5.4.3**, vibration monitoring would be required at the nearest affected receiver. Where it is anticipated that an item of plant will exceed the human response / ground borne noise criteria and concerns have been raised regarding vibration, vibration monitoring would also be required at the receiver(s) under question.

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

9.4. Blast Monitoring

- As specified in the minimum requirements presented in Section 5.7, vibration and overpressure monitoring would be conducted for all PCF and blasting activities which take place on Sydney Metro construction sites.
- Monitoring would be conducted as a minimum at the sensitive receiver(s) likely to receive the maximum vibration and/or overpressure emissions from the blast as identified by an acoustic consultant.

All blast monitoring results would be assessed against the nominated goals and compiled into a report to be forwarded to the construction contractor and project manager. All blast monitoring reports would also be made available to the public through the Sydney Metro website.

As the effect of vibration and overpressure from blasting have the potential to cause structural damage to buildings and services, accurate records of all blasts are required to be maintained. Such records would describe the location of the blast and all the blastholes, the design of the blast in terms of type of explosives, mass of explosives, initiating system used, ground vibration and overpressure measurement data.

Records of every blast would be kept for a minimum of seven years. A longer period of retention of the records may be warranted if a construction project is blasted over an extended or disrupted period.

For any section of tunnel construction where blasting is proposed, a series of initial trials at reduced scale shall be conducted prior to production blasting to determine site-specific blast response characteristics and to define allowable blast sizes to meet the airblast overpressure and ground vibration limits.

9.5. Dilapidation Surveys

If construction activities have the potential to cause damage through vibration to nearby public utilities, structures, buildings and their contents, an Existing Condition Inspection of these items is required to be undertaken in accordance with AS 4349.1 "*Inspection of Buildings*".

Prior to conducting the Existing Condition Inspections, the property owners will be advised of the inspection scope and methodology and the process for making a property damage claim. At the same time, maintain a register of all properties inspected and of any properties where owners refused the inspection offer.

The findings of all dilapidation surveys conducted for each Sydney Metro construction site would be complied into a report to be forwarded to the construction contractor and project manager. Follow-up Condition Inspections would be required at the completion of certain major works (eg completion of shaft bulk excavation works).

10. COMPLAINT HANDLING

All complaints handling would be in accordance with the Sydney Metro Construction Complaints Management System.

11. COMMUNITY CONSULTATION AND LIAISON

All community consultation would be in accordance with Sydney Metro Overarching Stakeholder and Community Involvement Plan.

12. DOCUMENTATION REQUIREMENTS

Any acoustic assessment, CNIS or CNVMP undertaken for the Sydney Metro project must document the following as a minimum (where applicable):

- Acoustic Terminology / Glossary
- Overview of the Project / Works
- Secretary's Environmental Assessment Requirements
- EPL conditions (if applicable)
- Site Plan and Sensitive Receivers
- Ambient Noise Monitoring: methodology, locations, analysis and results
- Construction Noise and Vibration Criteria
  - Construction Airborne Noise Criteria
  - Construction Tunnelling Ground-borne Noise Criteria (if applicable)
  - Construction Ground-borne Noise Criteria
  - Construction Vibration Criteria
- Construction Noise and Vibration Assessment
  - Construction Airborne Noise Methodology / Predictions
  - Construction Tunnelling Ground-borne Noise Methodology / Predictions (if applicable)
  - Construction Ground-borne Noise Methodology / Predictions
  - Construction Vibration Methodology / Predictions
- Summary of Noise and Vibration Impacts
- Summary of all Standard and Additional Mitigation Measures
- References

All noise and vibration predictions are to be presented (as a minimum) as facade noise maps for a distance of at least 300 m in all directions from each work site / project area under assessment.

13. REFERENCES

Related Documents and References
• ANZECC, 1990, Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration. Australian and New Zealand Environment Council.
• APTA, 1981, Guidelines for Design of Rapid Transit Systems. American Public Transit Association.
• AS 2107, 2000, Acoustics - Recommended design sound levels and reverberation times for building interiors. Standards Australia.
• AS 2012 Part 1, 1990, Acoustics - Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors - Stationary test condition - Determination of compliance with limits for exterior noise. Standards Australia.
• AS 2187, Part 2, 2006, Explosives - Storage and Use - Part 2: Use of Explosives. Standards Australia.
• AS 2436, 1981, Guide to Noise Control on Construction, Maintenance and Demolition Sites. Standards Australia.
• AS 4349, 2007, Inspection of buildings - General requirements. Standards Australia.
• BS 6472, 2008, Evaluation of Human Exposure Vibration in Buildings. The British Standards Institution.
• BS 7385 Part 2, 1993, Evaluation and Measurement for Vibration in Buildings Part 2. The British Standards Institution.
• Colin G. Gordon, 1999, Generic Vibration Criteria for Vibration-Sensitive Equipment. International Society for Optical Engineering.
• The Association of Australian Acoustical Consultants (AAAC) Technical Guideline on Child Care Centre Noise Assessments
• DECC, 1999, Environmental Criteria for Road Traffic Noise. NSW Department of Environment and Climate Change.
• DECC, 2009, Interim Construction Noise Guideline. NSW Department of Environment and Climate Change NSW.
• EN ISO 9641, Part 2, 1996, Acoustics - Determination of sound power levels of noise sources using sound intensity – Part 2: Measurement by scanning. International Organization for Standardization.
• EPA, 2000, NSW industrial noise policy. NSW Environment Protection Authority.
• RTA, 2001, Environmental noise management manual, NSW Roads and Traffic Authority.
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• TIDC, 2007, Construction noise strategy. Transport Infrastructure Development Corporation (NSW).

APPENDIX A - Construction Noise and Vibration Monitoring Guideline

This document is intended to provide guidance and outline the minimum requirements for contractors undertaking construction noise and vibration monitoring on the Sydney Metro Project. It should be read in conjunction with the requirements of the Construction Noise and Vibration Strategy (CNIS), the EPA's Interim Construction Noise Guideline (ICNG) and the conditions of approval.

Construction Noise and Vibration Impact Statements (CNIS) are to be developed prior to the commencement of demolition and construction to assess the potential impact of noise and vibration at surrounding noise sensitive receivers and, where necessary, to develop detailed noise and vibration mitigation and management plans. The plans shall identify suitable monitoring locations; the types of instruments to be used; the timing duration and frequency of monitoring; and whether the monitoring is to be operator-attended or unattended.

The objectives of monitoring are as follows:

Attended

- confirm source noise and vibration levels used for predictions
- confirm noise and vibration levels at receivers are consistent with predictions
- confirm suitability of mitigation measures and provide evidence to support corrective action
- investigate alerts and alarms from unattended monitoring (see below)
- verify measured unattended noise and vibration levels
- provide a record of construction noise and vibration levels for complaints management

Unattended

- confirm noise and vibration levels near receivers are consistent with predictions,
- confirm suitability of mitigation measures and provide evidence to support corrective action
- providing a continuous record of noise and vibration levels, for use in incident or complaint investigations
- providing notification (alerts and alarms) to project staff if levels exceed pre-determined thresholds
- providing a record of construction noise and vibration levels

Monitoring for the Project will be required at the commencement of works and at regular intervals throughout the project (i.e. when new construction activities commence) to quantify the airborne noise, ground-borne noise and vibration levels associated with construction activities.

Monitoring would also be required in the event of a complaint being received and would be conducted at:

- the affected receiver; or
- if more than one affected receiver has been identified, at the nearest affected receiver; or
- where the nearest affected receiver refuses monitoring on their property, at the near point to that receiver within the site boundary.
- If it can be demonstrated that direct measurement of the construction site is impractical, alternative means of determining construction noise levels may be adopted in accordance with Chapter 11 of the NSW Industrial Noise Policy.

The contractor would need to determine the suitability of either attended or unattended monitoring for each monitoring event.

1. Construction Noise Monitoring

The noise measurement procedures employed throughout the monitoring program will be in accordance with the requirements of Australian Standard (AS) 1055:1997 Acoustics - Description and Measurement of Environmental Noise and the NSW Department of predicted levels.

Measurements are expected to consist of operator-attended and unattended measurements. All noise measurements will be performed and analysed by a suitably qualified acoustical consultant.

1.1. Noise Monitoring

Noise monitoring for the Project will be required at the commencement of works and at regular intervals throughout the project to quantify the airborne and ground-borne noise levels associated with the construction activities for comparison against the noise management levels and to confirm that noise levels at the nearest receivers are consistent with the predictions in the CNISs.

All noise monitoring results will be assessed against the nominated noise criteria, compared to the conditions on the consent / licence, or the relevant noise management objectives and summarised in a report. Reporting would be submitted to the construction contractor and project manager within one week of being undertaken or at weekly intervals for continuous monitoring. Where monitoring has been conducted in response to complaints, these reports will be submitted within 3 days to TfNSW and should be suitable for public distribution.

1.2. Airborne Noise

1.2.1. Operator-Attended Monitoring

The objective of operator attended monitoring is to accurately quantify the airborne noise levels associated with the construction activities for comparison against the noise management levels and to confirm that noise levels at the nearest receivers are consistent with the predictions in the CNVSs.

Operator-attended noise measurements are to be undertaken at the commencement of any new construction activities or location.

The operator-attended noise measurements must be undertaken at a location representative of the potentially most exposed receivers, or alternatively at other specifically identified sensitive receivers (i.e. in complaint locations).

1.2.2. Continuous Noise Monitoring

Continuous noise monitors may be installed (as determined appropriate by the Project team in areas identified as high risk level or repeated complaints) and positioned at the closest sensitive receiver, where practicable (dependent upon the location of construction works).

These units will enable review of the noise levels at the nearest sensitive receivers and, if necessary, provide triggers to modify construction activities where noise levels are higher than predicted.

Consideration should be given to the implementation of real-time or near real-time remote monitoring systems. Such systems may be beneficial in identifying the source of the noise management level exceedance, identifying the occurrence of false-positive trigger events, and provide real-time feedback to the project team on the potential impact of works in relation to the management levels. Real-time remote monitoring systems may be acceptable for the monitoring of airborne noise, ground-borne noise, and vibration.

1.3. Methodology

Monitoring will be conducted in accordance with Australian Standard (AS) 1055:1997 Acoustics – Description and Measurement of Environmental Noise and the INP (DECC, 2000).

Operator-attended noise measurements are to be conducted during normal Project operations to quantify the noise emissions and potential impacts from the Project.

Timing

Operator-attended noise monitoring will be conducted for a minimum of 15 minutes at each location during the subject construction activities. Where a longer monitoring duration is required, measurements must be made in consecutive 15 minute periods.

Measurement

All acoustic instrumentation used in the monitoring programme will be designed to comply with the requirements of AS IEC 61672.1:2004 Electroacoustics – Sound level meters – Specifications and carry current National Association of Testing Authorities (NATA) or manufacturer calibration certificates.

The operator will quantify and characterise the maximum (L_{Amax}) noise level and the energy average ($L_{Aeq(15minute)}$) noise level from construction activities over a 15 minute measurement period.

In addition, the operator will quantify and characterise the ambient level of noise (i.e. L_{Amax}, L_{A1}, L_{A10} and L_{A90}) over the measurement period, where possible.

Instrument calibration will be checked before and after each measurement survey, with the variation in calibrated levels to not exceed ±0.5 dBA.

Assessment of Results

The assessment of the results will be undertaken in comparison to the predicted noise levels in the appropriate CNVIS. In the event of the measured nose levels being higher than predicted, an assessment will be conducted to determine:

- Timing, location and the equipment in use during the exceedance.
- Exclusion of non-Project related noise (e.g. can the exceedance be attributed entirely to the Project). This will include consideration of:
  – the methods and type of equipment being used by the project at the time of the exceedance and proximity to the locations at which the exceedance was recorded
  – the location of non-project related activities and proximity to the locations at which the exceedance was recorded.

If the above assessment determines that the noise levels are due to Project noise then noise mitigation measures detailed in Section 7 of the CNIS will be required to be considered.

Measurement Reporting

The following should be included in as a minimum in noise monitoring report:

- The type of monitoring conducted (for example, at a particular project stage or following complaints) and a brief statement of the measurement method.
- The noise/vibration/blasting conditions on the consent / licence, or the relevant noise management objectives.
- Descriptions of the nearest affected residences and other sensitive land uses or, in the case of complaints, description of the complainant location and complaint.
- Description of the instrumentation used (the instrumentation specifications required for compliance noise monitoring are the same as those required for background noise monitoring set out in Appendix B of the NSW Industrial Noise Policy (EPA 2000))
- The results of monitoring at each monitoring location, including a comparison with the consent conditions or relevant noise management objectives
- The location of the construction works in relation to the monitoring position. (sketch plan & sections, photos)
- Details of the various construction equipment in use during the measurement period.
- Indicative noise levels at the measurement location from the operation of the various plant items, together with the observed duration of individual items.
- Details as to the likely dominant noise sources.
- Meteorological conditions (i.e. temperature, humidity, cloud cover, and wind speed and direction)
- A clear statement outlining the project’s compliance or non-compliance with the conditions or objectives where the monitored level is higher than the conditions or objectives,
- The reasons for non-compliance should be stated, strategies for minimising noise identified and stated, and the appropriate actions to implement the mitigation and or management strategies.

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2. Cosmetic Damage Vibration Monitoring

2.1. General

Where it is anticipated that an item of plant will exceed the cosmetic damage criteria, vibration monitoring is required at the nearest affected receiver. Where concerns have been raised regarding vibration, vibration monitoring would be required at the receiver(s) in question.

All vibration monitoring results will be assessed against the nominated vibration goals and compiled into a report to be forwarded to the construction contractor and project manager and TfNSW. Reporting would be submitted within one week of being undertaken or at weekly intervals for continuous monitoring. Where monitoring has been conducted in response to complaints, these reports will be submitted within 3 days to TfNSW and should be suitable for public distribution if deemed necessary by TfNSW.

2.2. Vibration Compliance

All monitoring results will be assessed against the nominated criteria, compared to the conditions on the consent / licence, or the relevant management objectives.

Table 17 Nominated Site Control Vibration Criteria (ie Operator Warning and Halt Levels) - To be Measured at the Base

Structure	Site Control Criteria (PPV in any Orthogonal Direction)	
	Operator Warning Level	Operator Halt Level
Reinforced of framed structures	20 mm/s	25 mm/s
Unreinforced or light framed structures	5 mm/s	7.5 mm/s
Heritage	1.5 mm/s	2.5 mm/s

Exceedance of the “Operator Warning Level” would not require excavation activity to cease, but rather alerts the Construction Manager to proceed with caution at reduced force or load.

An exceedance of the “Operator Halt Level” would require the Construction Manager to implement an alternative excavation technique pending further analysis of the vibration frequency content in order to determine any potential exceedance of the criteria presented in the CNVS or the site specific CNVIS.

Vibration monitoring equipment must be set so that as a minimumm visual and audible alarms are triggered when the levels of vibration exceed the control criteria presented in **Table 17**.

If the “Operator Warning Level” is reached, the contractor will immediately, either:

- Reduce the number of vibration-generating plant/equipment items; or
- Cease operation, pending further analysis of the potential for building damage. A suitably qualified specialist acceptable to the construction contractor must endorse the conclusions of such an investigation.

2.3. Other Vibration Sensitive Structures and Utilities

Where structures and utilities are encountered which may be considered to be particularly sensitive to vibration, a vibration goal which is more stringent than structural damage goals presented in Section 5.4 of the CNVS may need to be adopted. Examples of such structures and utilities include:

- Tunnels
- Gas pipelines
- Fibre optic cables
- Medical or vibration sensitive equipment.

Specific vibration goals would be determined on a case-by-case basis. An acoustic consultant would be engaged by the construction contractor and would liaise with the structure or utility's owner in order to determine acceptable vibration levels.

2.4. Vibration Monitor Specification

Construction vibration monitoring instrumentation used for the identification of structural and cosmetic damage will be employed that meets the following primary specifications presented in **Table 18**. The instrumentation must be installed, operated and maintained by suitably qualified or trained personnel. The instruments must be externally calibrated at regular intervals.

Table 18 vibration Monitor Specifications

Specification	Seismic
Resolution	0.016 mm/s
Range	0.1 mm/s to 254 mm/s
Accuracy	3% at 15 Hz
Sample Rate	Minimum 1024 samples per second per channel
Frequency Response	2 Hz to 250 Hz (3 dB points)
Communications Link	Keyboard and Modem
Recording Mode	Waveform Recording and archiving

It should be noted that equipment specifications detailed in **Table 18** may not be suitable for the measurement of all vibration impacts such as human comfort and or the measurement of vibration impacts to sensitive equipment. Prior to any measurement being conducted the contractor must ensure that the monitoring equipment being proposed is suitable for the type of measurement being conducted.

2.5. Vibration Monitoring

Structural vibration monitoring must be carried out as required during the construction period.

Transducer mounting plates would be installed at the base of the building or structure, at the location closest to the construction works. The monitoring locations would be on a stiff part of the building or structure (at the foundations) on the side of the structure adjacent to the subject construction works.

The vibration monitoring system must be configured to record the peak vibration levels and to trigger an audible/visual alarm when the predetermined vibration thresholds nominated in **Table 17** are exceeded. The thresholds correspond to an "Operator Warning Level" and an "Operator Halt Level", where the Warning Level is between 66% and 80% of the Halt Level.
The vibration threshold must be set to the respective "Operator Warning Level" (ppv) and the "Operator Halt Level" (ppv) depending on the type of building or structure, the exceedance of which will be indicated by the audible/visual alarm in the construction site.

Should the alarm signalling "Operator Halt Level" be activated then all nearby construction works must stop immediately. Construction personnel engaged on the site must have been briefed on the procedures including the location and nature of audio and visual alarms. The audio and visual alarms must be arranged to directly alert the equipment operations to any alarm event.

Exceedances of the "Operator Halt Level" are only permissible when the recommended vibration limits in the Standard are achieved (based on the frequency content of the vibration signal) and the vibration criteria are approved by a suitably qualified specialist.

An exceedance of the "Operator Warning Level" will not require the excavation activities to cease, but rather alert the Construction Manager to proceed with caution at a reduced force or load.

Attended vibration monitoring will, if considered necessary, be carried out by a suitably qualified specialist. Attended structural damage vibration monitoring must be carried out in response to structural damage criterion exceedances. This monitoring would provide direct feedback to the operators and appropriate modification of construction techniques.

Supplementary Vibration Monitoring

Supplementary structural damage vibration monitoring must also be carried out in response to exceedances of the criteria or for the purpose of refining construction techniques in order to minimise vibration emissions. Monitoring would be attended under these circumstances, in order to provide immediate feedback to the operators.

Reporting

If vibration monitoring has been conducted, reports must be submitted to the Project Manager at weekly intervals. These reports will cover the preceding weeks' activities and will include the following:

- The type of monitoring conducted (for example, at a particular project stage or following complaints) and a brief statement of the measurement method.
- The vibration/blasting conditions on the consent / licence, or the relevant management objectives.
- Descriptions of the nearest affected residences and other sensitive land uses or, in the case of complaints, description of the complainant location and complaint.
- Vibration monitoring results summary together with notes describing any vibration-intensive activities (if applicable).
- Summary of measurements exceeding the vibration criteria levels and descriptions of the plant or operations causing these exceedances (if available).
- Details of corrective action applicable to vibration criteria exceedances and confirmation of its successful implementation. Where corrective action has not yet been implemented, it may be shown as pending and the status of its implementation will be carried forward to following reports.

2.6. Ground-borne Noise and Vibration

Operator-attended and unattended noise and vibration monitoring will be conducted where the ground-borne noise and vibration levels are higher than predicted, or in response to complaints. People tend of hear vibration before they feel vibration; that means that if the ground-borne noise criteria are exceeded then the human comfort criteria for vibration could also be exceeded.

Where attended ground-borne noise monitoring is not possible, indirect unattended remote monitoring[4] of ground-borne noise from measured vibration velocity should be considered to obtain an indication of ground-borne noise impacts and assist in management of impacts.

[4] "Monitoring ground borne and structure borne noise for management of construction impacts" D.Anderson,D.Sburlati, Proceedings of ACOUSTICS 2016 , 9-11 November 2016, Brisbane, Australia.

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Appendix F

Sustainability Strategy

sydney METRO | city & southwest

Sustainability Strategy

2017–24

July 2017

Transport for NSW

NSW MAKING IT HAPPEN

CONTENTS

Cover: Artist's impression of Barangaroo Station
This page: Sydney's new metro train

FOREWORD

Sydney Metro is Australia's biggest public transport project – a new stand-alone railway that will deliver 31 metro stations and 66 kilometres of new metro rail, revolutionising the way Australia's biggest city travels.

The Sydney Metro City & Southwest project is the second stage of the Sydney Metro program, extending from Chatswood, under Sydney Harbour, through the central business district (CBD) and beyond to Bankstown. It includes seven new metro stations and the upgrade of all 11 existing stations between Sydenham and Bankstown.

At both a program and project level, we recognise the need to be environmentally and socially responsible. This includes reducing carbon emissions, managing resources, optimising land development potential, and promoting healthy communities.

Sustainability underpins the core project objectives for the City & Southwest project and is integrated across project targets and initiatives. This Sustainability Strategy is designed to engage with industry to develop ideas for additional opportunities to deliver the project sustainably.

Together we can build on the outstanding sustainability legacy of Stage 1 of Sydney Metro – the $8.3 billion Sydney Metro Northwest project – by incorporating lessons learned and exploring new opportunities that strive for leadership and innovation.

Transport for NSW is working hard to set new benchmarks in the delivery of major infrastructure projects and looks forward to sharing these achievements with our customers and key stakeholders.

Rodd Staples

PROGRAM DIRECTOR
SYDNEY METRO

Artist's impression of Martin Place Station

SUSTAINABILITY STRATEGY HIGHLIGHTS

Construction

During tunnelling activities, the **total excavated spoil** (2.4 million cubic metres) could fill **Darling Harbour twice**

100% clean spoil will be beneficially reused

90% **of construction and demolition waste** will be recycled

25% reduction in Portland cement in concrete, saving the equilvalent carbon emissions of planting **784,000 trees**

Offsetting 25% of construction electricity will reduce carbon emissions by the equivalent of planting **225,800 trees**

Operations

100 households (20,000kL) of water usage per year will be saved through the Project's use of water efficient fixtures and rainwater harvesting

Onsite solar panel **renewable energy** systems at stations will be sufficient to power up to **200 households (1280MWh)**

Improved pedestrian and cycling connections will make walking and cycling easier, resulting in health benefits to customers

Secure access and **covered bicycle parking** spaces will be provided

100% of **timber products** will be from reused, recycled or responsibly managed sources

100% of the **operational electricity** needs for the project will be offset (which is an estimated 221 Gigawatt hours a year). This will be the equivalent to the energy generated by 1.1 million solar panels (240 hectares solar plant) or 40 wind turbines

Station energy performance improvements (such as lighting systems and efficient glazing) will save the equivalent electricity consumption of approximately **610 households** a year

Accurate May 2017 (subject to change and pending confirmation in the detailed design process

17032 6/2017

1 INTRODUCTION

Sydney Metro has a clear vision for the Sydney Metro City & Southwest project (the Project) to demonstrate best-practice environmental, social and economic outcomes in delivery and operation.

Sustainability underpins the core project objectives and is integrated across all project stages.

This Sustainability Strategy document and appendices outlines performance targets, initiatives and outcomes which will be adopted across key policy areas in the design, construction and operation stages of the Project.

The targets are benchmarked against world best practice on similar infrastructure projects. Targets within this document will be embedded into contract documents to drive improvements and innovation.

The strategy articulates how the project team will maximise the delivery and operation of the Project's sustainability requirements.

The approach to addressing sustainability for the Project is built on that adopted for Sydney Metro Northwest, incorporating lessons learned, and responding to intervening drivers and location-specific opportunities and constraints.

For Sydney Metro, 'sustainability' means optimising environmental and social outcomes, transport service quality, and cost effectiveness.

Artist's impression of Barangaroo Station

2 PROJECT OVERVIEW

2.1 Project scope

The Sydney Metro City & Southwest project extends metro rail from the north west, under Sydney Harbour, through the CBD and south west to Bankstown. It is due to open in 2024 with seven new metro stations and 11 upgraded stations.

Sydney Metro City & Southwest has two components:

› Chatswood to Sydenham – new 15-kilometre twin tunnels from Chatswood, under Sydney Harbour through Sydney's CBD to Sydenham

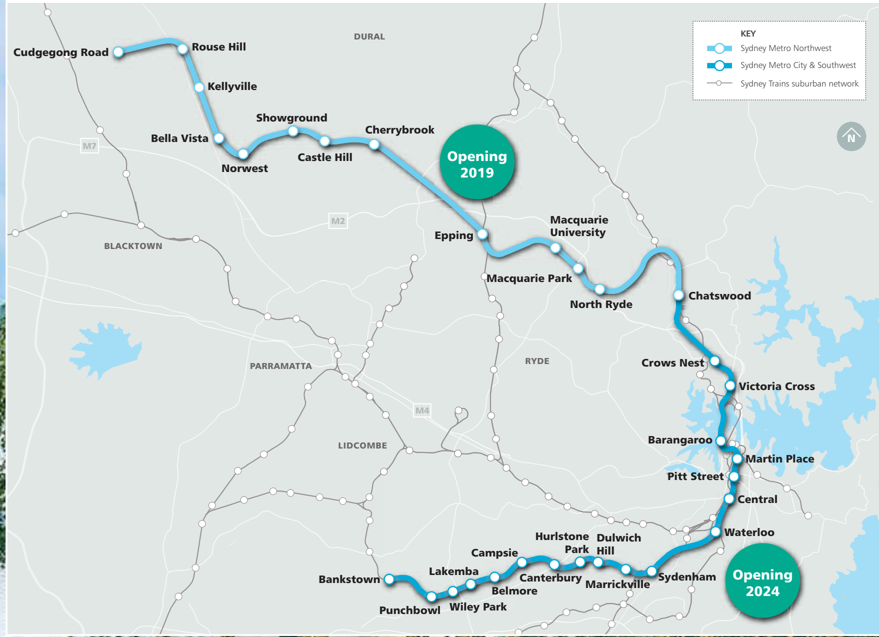
› Sydenham to Bankstown upgrade – upgrade and conversion of the existing 13.5-kilometre railway from Sydenham Station to Bankstown Station to metro standards, including upgrading the 11 existing stations.

The Project will deliver seven new metro stations, at:

› Crows Nest
› Victoria Cross (North Sydney)
› Barangaroo
› Martin Place
› Pitt Street
› Central Station (new underground platforms)
› Waterloo.

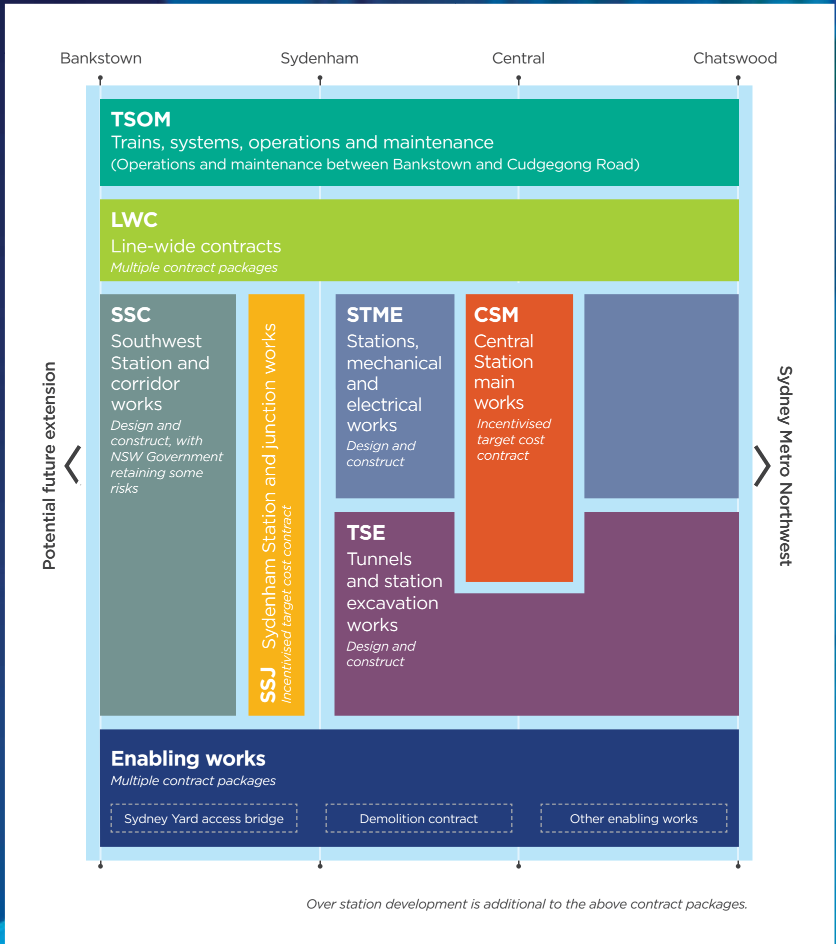
The Project will be delivered via a series of contract packages, as outlined in Figure 2.

Figure 1 The Sydney Metro network



Artist's impression of Crows Nest Station

Figure 2 Sydney Metro City & Southwest contract packages



2.2 Over Site Development and Rail Corridor Development

The Project also includes 'over site development' (OSD) at station and dive locations between Chatswood and Sydenham. Being located in dense urban areas and above high-capacity stations, the OSDs will be significant contributors to the urban landscape.

The OSDs will comprise;

- multi-storey residential and commercial buildings
- development of integrated property developments in connection with metro stations
- development of surplus land which is no longer required after the construction phase.

Sydney Metro is completing preliminary planning for the OSD, securing planning approvals and developing concepts, for sale and development by others.

Transport for NSW (TfNSW) is also investigating the feasibility of rail corridor development (RCD), including the development of residual land in and adjacent to the rail corridor between Sydenham and Bankstown for a variety of uses, including mixed use, commercial and residential development.

Sydney Metro will be seeking best-practice sustainable design and governance outcomes for OSD and RCD (if included in the Project scope), including:

- achieving high benchmarks using Green Star Design and As Built ratings and Green Star Communities ratings where appropriate
- achieving high benchmarks using NABERS and BASIX ratings
- site specific responses to the Project's sustainability objectives
- investigation and inclusion of affordable housing where appropriate.

Sydney Metro will be seeking **best practice** sustainable design and governance outcomes

Above: Development at Barangaroo
Right: Artist's impression of Waterloo Station

2.3 Project benefits

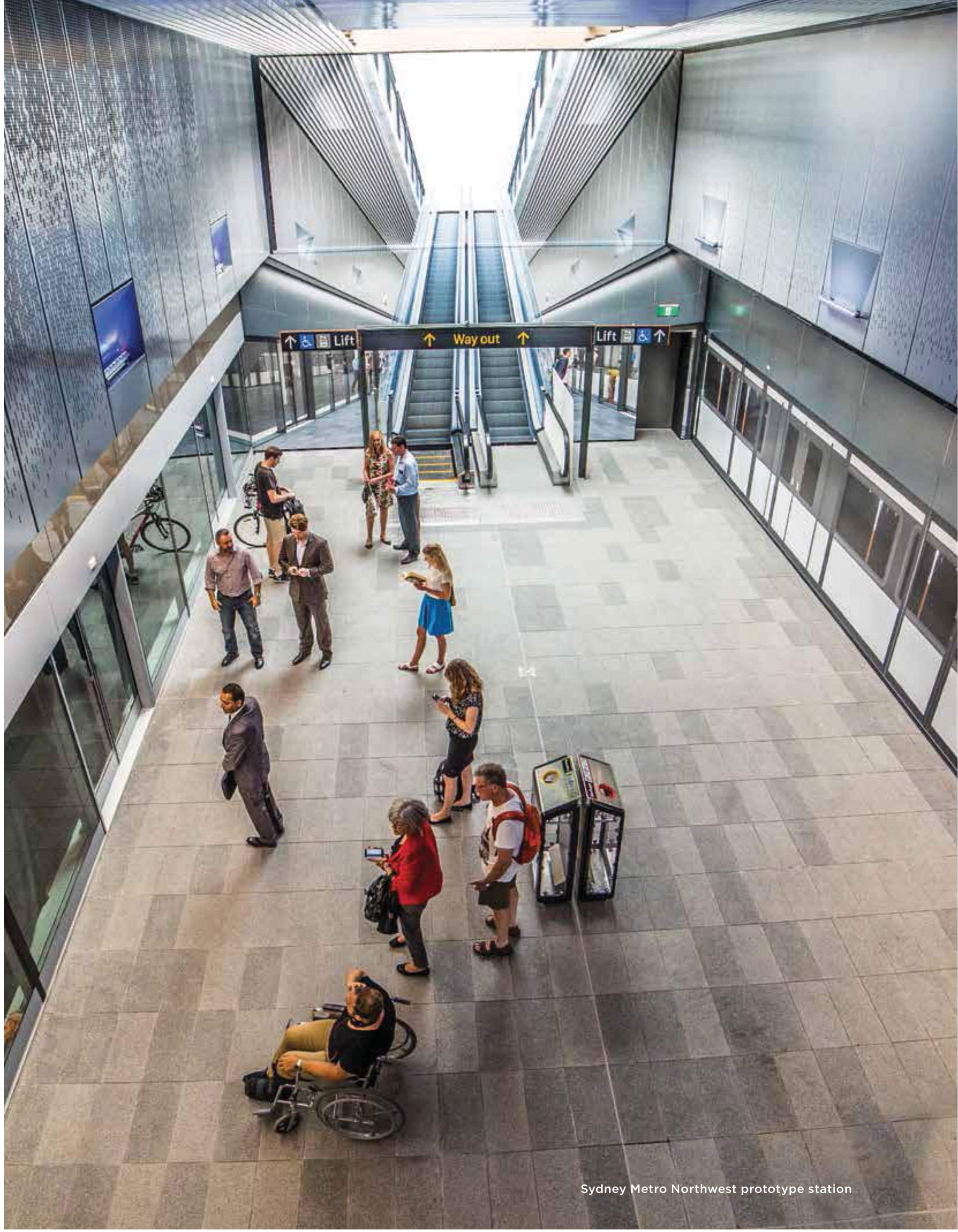
Benefits of the Project include:

› Transport benefits:
  - Enabling the long-term growth of the Sydney rail network.
  - Caters for growth in demand, from an estimated 168,400 to 288,000 trips in the one-hour AM peak by 2036[1].
  - Increased accessibility and trip diversity.
  - Increased rail network capacity.
  - Improved network resilience.
  - Improved transport integration.
  - Providing demand relief for Sydney Trains lines (T1 North Shore Line; T1 Western Line; T2 Airport, Inner West and South Line; and T3 Bankstown Line).
  - Improved conditions for bus passengers and road users through supporting and managing growth.
  - Increased rail network reach and use.
  - Provides customers with significant travel time savings and increased reliability and comfort.
  - Enhanced safety features.
  - Improved bus services and improved pedestrian and cyclists access'.

› Sustainability benefits:
  - The Project is an enabler which will encourage greater urban infill rather than greenfield housing developments which results in infrastructure savings for the taxpayer.
  - By attracting more people to the medium and higher density dwellings there would be household cost savings for the consumption of utilities (electricity, gas and water) and transport.
  - Health benefits from sustainable living – the Project has the potential to result in a reduction in public health care costs as it will be enabling more customers to access public transport by walking and cycling[2].

› Broader city building benefits:
  - Peak additional employment during the construction period of 6200 workers[3]
  - approximately $8.5 million per annum additional value-add in 2036, from increased co-location and productivity of businesses and workers in the corridor[4.]
  - Stimulating approximately 44,000 additional jobs in the Global Economic Corridor by 2036, providing greater access to and between employment opportunities, education and health precincts, retail and commercial centres and cultural and open spaces[5].

[1] Sydney Metro City & Southwest Business Case Summary, October 2016, page 26
[2] Sydney Rapid Transit Business Case, October 2014, page 7–41
[3] Sydney Metro City & Southwest Business Case Summary, October 2016, page 26
[4] Sydney Metro City & Southwest Business Case Summary, October 2016, page 26
[5] Sydney Metro City & Southwest Business Case Summary, October 2016, page 26



Sydney Metro Northwest prototype station

3 DEVELOPMENT OF THE SUSTAINABILITY STRATEGY

3.1 Defining 'sustainability' for Sydney Metro

There are many definitions for 'sustainability' or 'sustainable development'. The most commonly referred to definition is in the Bruntland Report, which defined 'sustainability' as 'development which meets the needs of the present without compromising the ability of future generations to meet their own needs'[6].

The NSW Government has defined 'sustainability' as 'Sustainability in the NSW public sector means addressing the needs of current and future generations through the integration of social justice, economic prosperity and environmental protection in ways that are transparent, accountable and fiscally responsible.'

TfNSW Environment and Sustainability Policy (August 2015) reflects a commitment to 'delivering transport services, projects, operations and programs in a manner that balances economic, environmental and social issues to ensure a sustainable transport system for NSW.'

For Sydney Metro, 'sustainability' means building a metro system for current and future generations, that optimises environmental and social sustainability outcomes, transport service quality and cost effectiveness.

[6] Bruntland, G. (ed.), 1987, Our Common Future: The World Commission on Environment and Development, Oxford University Press, Oxford

Artist's impression of Campsie Station

3.2 Purpose and scope of the strategy

The purpose of this Sustainability Strategy is to outline performance targets, initiatives and outcomes which will be adopted across key policy areas in the design, construction and operation stages of the Project. The intention is to review and update this strategy as required, as the Project progresses.

This strategy supersedes the initial sustainability strategy for the Project, which was finalised in November 2015 and provided a framework for integrating sustainability into early project planning, design and procurement of the Project.

There are many elements to the broader definition of sustainability. This Sustainability Strategy focuses on those areas identified in Figure 3.

Appendix A outlines the Conditions of Approval (CoA), revised mitigation measures and revised environmental outcomes relating to sustainability for the Chatswood to Sydenham component, and where each item is addressed within this strategy to demonstrate compliance. This strategy will be reviewed as additional planning approvals are secured for the Project.

A separate sustainability strategy is being developed for the Over Site Development and Rail Corridor Development as described in Section 2.2.

This strategy outlines **performance targets, initiatives and outcomes** which will be adopted by the Project.

Above: Landscaping initiatives
Right: Public exhibition and community consultation, Sydney, May 2016

Figure 3 Sydney Metro sustainability elements

Environment	Social	Economic
Climate change	Heritage	Whole-of-life costs
Carbon	Community benefit	Value for money
Energy	Liveability	
Water	Supply chain	
Waste	Workforce development	
Materials	Community consultation	
Pollution	Customer	
Biodiversity	Safety	
Supply chain	Wellbeing	

Addressed in other Sydney Metro strategy documents.

3.3 Development of this strategy

This strategy has been developed by:

› using the Sydney Metro Northwest sustainability strategy, policy and objectives as a starting point

› incorporating lessons learned in the implementation of the Sydney Metro Northwest strategy and early outputs of a review of the strategy which was completed in 2016 by Ernst & Young (see below)

› considering project-specific opportunities and constraints as environmental studies have been completed as part of ongoing assessments

› formulating an appropriate response to regulatory and other drivers

› benchmarking the sustainability performance and approaches taken on other recent large infrastructure projects in Australia and internationally.

The sustainability framework illustrated in Figure 4 outlines how the above components provide input (outlined in further detail in Appendix B) into the development of the Project's sustainability policy objectives, targets and initiatives that are detailed in Sections 3.4–3.7 and Appendices C–N of this Strategy.

Ernst & Young (EY) has completed a review of the **Sydney Metro Northwest Sustainability Strategy** and performance to date against the objectives and targets set out in the strategy. Findings indicate that, of the 43 performance targets established for the Project:

› 85 per cent of the targets are either being met or on track to being met.

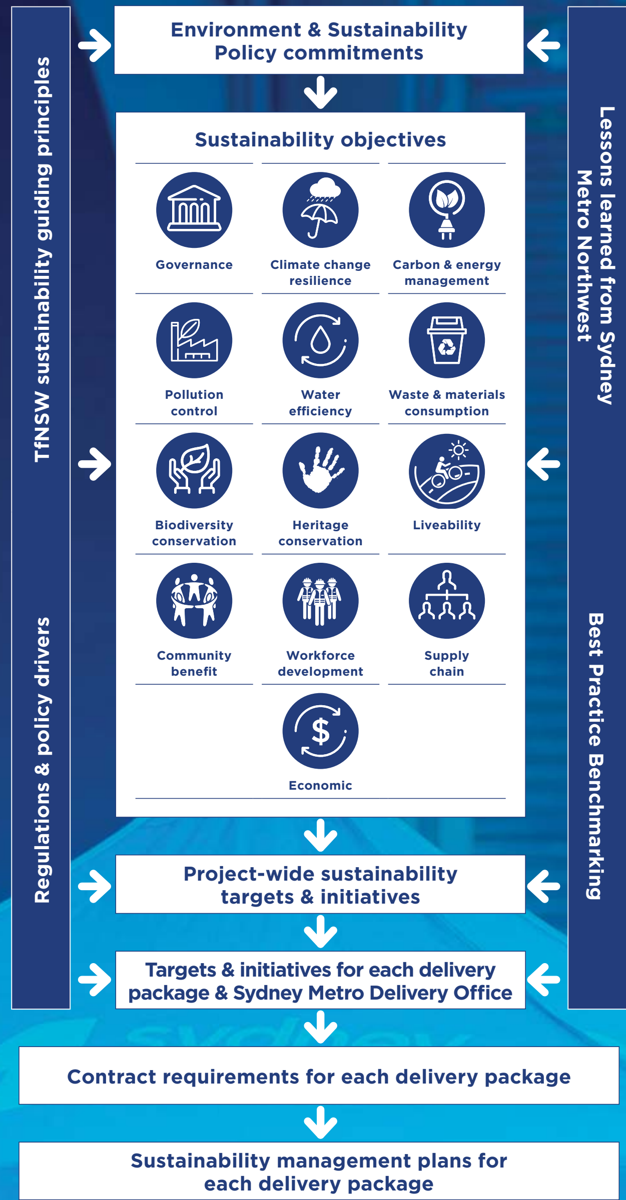
› 10 per cent of the targets are not being met, but the overall intent of the target is being met.

› 5 per cent of the targets are no longer applicable to the Project.

Based on the assessment, EY is of the view that 'the scope of the Sustainability Strategy... and the performance to date of the Sydney Metro Northwest project... are in keeping with international best practice for similar project.'

Above top: Construction workers in tunnel (Sydney Metro Northwest)
Above: Water-sensitive urban design, Victoria Park, Sydney

Figure 4 Sustainability framework



3.4 Sustainability policy

An Environment & Sustainability policy has been developed to articulate Sydney Metro's commitment to sustainable outcomes on the Project, and is included in Figure 5. The policy is based on that which was adopted for Sydney Metro Northwest, with some updates to capture the workforce development agenda for the Project. This policy will be reviewed by the project team every two years to ensure any new initiatives and developments are captured.

Figure 5 Transport for NSW Sydney Metro Environment & Sustainability Policy (April 2016)

NSW GOVERNMENT | Transport for NSW

Environment & Sustainability Policy

sydney METRO

This Policy reflects a commitment in our delivery of the Sydney Metro program to:

- Align with, and support, Transport for NSW (TfNSW) Environment & Sustainability Policy.
- Optimise sustainability outcomes, transport service quality, and cost effectiveness.
- Develop effective and appropriate responses to the challenges of climate change, carbon management, resource and waste management, land use integration, customer and community expectation, and heritage and biodiversity conservation.
- Be environmentally responsible, by avoiding pollution, enhancing the natural environment and reducing the project ecological footprint, while complying with all applicable environmental laws, regulations and statutory obligations.
- Be socially responsible by delivering a workforce legacy which benefits individuals, communities, the project and industry, and is achieved through collaboration and partnerships.

To deliver on these commitments, the Sydney Metro team will:

Industry leadership

- Implement coordinated and transparent decision making, by engaging with stakeholders and suppliers, encouraging innovation and demonstrating sustainability leadership.
- Explore new benchmarks for the transport infrastructure sector by requiring high standards from our designers, contractors and suppliers, building on experience gained through development of Sydney Metro Northwest.

Community and customer

- Provide accessible, safe, pleasurable, and convenient access and transport service for all customers.
- Establish positive relationships with community and stakeholders to maximise opportunities to add value to local communities.

Land use integration and place making

- Create desirable places, promote liveability and cultural heritage, and optimise both community and economic benefit.
- Balance transit oriented development opportunities with stakeholder expectations.

Embedding environmental and social sustainability

- Establish robust sustainability objectives and targets.
- Maintain an environmental management system that is integrated into all our project activities.
- Ensure thorough and open environmental assessment processes are developed and maintained.
- Develop and maintain an environmental management framework to embed best practice pollution management and sustainable outcomes during construction.
- Apply effective assurance processes to monitor performance against the project environment and sustainability objectives and identify appropriate reward or corrective action, as required.
- Apply environment and sustainability specific processes to the procurement of delivery activities.

Accountability

- Undertake public sustainability reporting.
- Hold employees and contractors accountable for proactively meeting their environmental and social sustainability responsibilities.
- Provide appropriate training and resources necessary to meet our responsibilities.

Rodd Staples
Program Director, Sydney Metro

 SM ES-ST-209 Sydney Metro Environment and Sustainability Policy

Sydney Metro City & Southwest community consultation

3.5 Sustainability objectives

Sustainability objectives have been developed to incorporate the outcomes of a critical review of the sustainability objectives for Sydney Metro Northwest, consideration of the inputs detailed in Appendix B and consultation across Sydney Metro work streams. These objectives have been endorsed by the Sydney Metro Program Executive.

Table 1 Sustainability objectives

SUSTAINABILITY THEMES & OBJECTIVES

Governance	› Demonstrate leadership by embedding sustainability objectives into decision making. › Demonstrate a high level of performance against objectives and appropriate benchmarks. › Be accountable and report publicly on performance.
Carbon & energy management	› Improve the shift toward lower carbon transport. › Reduce energy use and carbon emissions during construction. › Reduce energy use and carbon emissions during operations. › Support innovative and cost effective approaches to energy efficiency, low-carbon / renewable energy sources and energy procurement.
Environmental performance	› Reduce sources of pollution and optimise control at source to avoid environmental harm. › Comply with environmental obligations outlined in applicable project planning approvals.
Climate change resilience	› Infrastructure and operations will be resilient to the impacts of climate change.
Resources – water efficiency	› Minimise use of potable water. › Maximise opportunities for reuse of rainwater, stormwater, wastewater and groundwater.
Resources – waste & materials	› Minimise waste through the Project lifecycle. › Reduce materials consumption. › Consider embodied impacts in materials selection. › Maximise beneficial reuse of spoil.
Biodiversity conservation	› Protect and create biodiversity through appropriate planning, management and financial controls.
Heritage conservation	› Protect and promote heritage through appropriate design, planning, and management controls.
Liveability	› Promote improved public transport patronage by maximising connectivity and interchange capabilities. › Provide well-designed stations and precincts that are comfortable, accessible, safe and attractive.
Community benefit	› Make a positive contribution to community health and well-being. › Ensure community and local stakeholder engagement and involvement in the development of the Project. › Contribute to the delivery of legacy projects to benefit local communities. › Create opportunities for local business involvement during the delivery and operations phases. › Optimise community benefit of residual land development. › Minimise negative impacts on the community and local businesses during construction and operation.
Supply chain	› Influence contractors, subcontractors and materials suppliers to adopt sustainability objectives in their works and procurement.
Workforce development	› Increase opportunities for employment of local people, participation of local businesses, and participation of SME's. › Enable targeted and transferable skills development which resolves local and national skills shortages, supports industry to compete in home and global markets, and embeds a health and safety culture within all induction and training activities, promoting continuous improvement. › Increase workforce diversity and inclusion, targeting indigenous workers and businesses, female representation in non-traditional trades, and long term unemployed. › Inspire future talent and develop capacity in the sector, engaging young people via education and work experience, collaborating with higher education institutions to provide programs responding to rapid transit and other infrastructure requirement, and supporting vocational career development through apprenticeships and traineeships.
Economic	› Consider adopting a whole-of-life costing model to maximise sustainability benefits. › Optimise development opportunities for residual land. › Capture sustainability benefits in the business case for the project.

3.6 Sustainability targets and initiatives

Targets and initiatives have been developed to support the above sustainability objectives for the Project. Sustainability targets represent performance aspirations across the Project. It is acknowledged that future developments in the design or other changes to the Project may affect our ability to meet all targets. Performance against targets will be monitored and reported on a regular basis.

Sustainability initiatives are detailed in Appendices C–N for each theme respectively and will be further refined as part of the design process and included in the contract documents for all detailed design, construction and operations contracts.

Project contractors will be required to clearly identify how they will ensure that specific sustainability objectives, initiatives and targets are met. This approach will encourage industry to develop innovative value-for-money sustainability solutions.

Table 2 Sydney Metro City & Southwest sustainability targets

SUSTAINABILITY THEMES & TARGETS

Governance	› A high level of attainment (minimum ISCA IS Rating of 65 'Excellent') for relevant infrastructure. › 5 Star Green Star ratings for relevant buildings. › Align with a high rating using the TfNSW Sustainable Design Guidelines.
Carbon & energy management	› Achieve at least a 20 per cent reduction in carbon emissions associated with construction, when compared to business as usual.* › Offset 25 per cent of the electricity needs for the construction phase of the project. › Achieve at least a 20 per cent reduction in carbon emissions associated with operations, when compared to business as usual.* › Maximise the capture and reuse of energy generated from braking trains. › Design buildings (stations and stabling buildings) to achieve at least a 15 per cent improvement over performance requirements set out in Section J of the National Construction Code. › Source 5-20 per cent of the low voltage electricity required at above ground stations from onsite renewable energy sources. › Offset 100 per cent of the electricity needs for the operational phase of the project.
Environmental performance	› Zero major pollution incidents. › New emission standards will be identified and applied to diesel equipment and vehicles during construction.
Climate change resilience	› Mitigate all extreme and high level risks. › Mitigate a minimum of 25 per cent of medium level risks (examples include increased flooding, increased temperatures, sea level rise, and increased storm events).
Resources – water efficiency	› Reduce water use by at least 10 per cent compared to business as usual.* › Source at least 33 per cent of the water used in construction from non-potable sources. › Source at least 33 per cent of the water used in operations from non-potable sources. › Implement rainwater harvesting and reuse systems at construction sites and above ground stations. › Source at least 60 per cent of the water used at above ground stations from harvested rainwater.
Resources – waste & materials	› Reduce the environmental footprint of materials used on the project by at least 15 per cent compared to business as usual.* › Use concrete which has an average Portland cement replacement level of more than 25 per cent. › 100 per cent beneficial reuse of usable spoil. › Recycle or reuse 90 per cent of recyclable construction and demolition waste. › Recycle or reuse 60 per cent of office waste during the construction phase. › Recycle or reuse 80 per cent of the waste generated during operations. › Recycle or reuse 65 per cent of office waste during operations. › 60 per cent of reinforcing steel is produced using energy-reducing processes in its manufacture. › Source 100 per cent reused, recycled timber or responsibly sourced timber.
Biodiversity conservation	› Minimise vegetation clearing. › Native landscaping targets to be established.
Heritage conservation	› Prepare a Heritage Strategy, including stakeholder engagement with relevant stakeholders. › Implement the Heritage Strategy during design and delivery, to conserve and activate. › Maximise opportunities for archaeological research and future interpretation of archaeological finds. › Opportunities for heritage interpretation identified and implemented at appropriate station precincts.
Liveability	› Station interchanges designed in accordance with the Interchange Access Plans and modal hierarchy › Stations and precincts designed in accordance with the Sydney Metro Design Guidelines › Maximise the provision of secure access and covered bicycle parking spaces, and safeguard for future expansion of bicycle parking
Community benefit	› Implement initiatives which will provide tangible benefits to local community groups during the construction period. › Implement initiatives which will provide tangible benefits to the broader local community beyond the construction period. › Identify key drivers for affordable housing and work with other lead agencies to identify opportunities and develop an appropriate response.
Supply chain	› All principal contractors develop and implement sustainable procurement strategies.
Workforce development	› Refer to the Sydney Metro City & Southwest Workforce Development and Industry Participation Strategy, which is a separate document to be read in conjunction with this strategy and outlines priorities, objectives and targets to address workforce development.

* Note: 'Business as usual' (BAU) is defined as that which is used in the applicable rating scheme for the respective target (e.g. ISCA Rating Tool, Green Star and TfNSW CERT).

Examples of design initiatives

Examples of sustainable design initiatives which are being considered for inclusion at new underground stations are illustrated in Figures 6, 7, and 8. These initiatives will continue to be evaluated throughout the detailed design process, and included where feasible.

Figure 6 Cross section highlighting sustainabiltiy opportunities

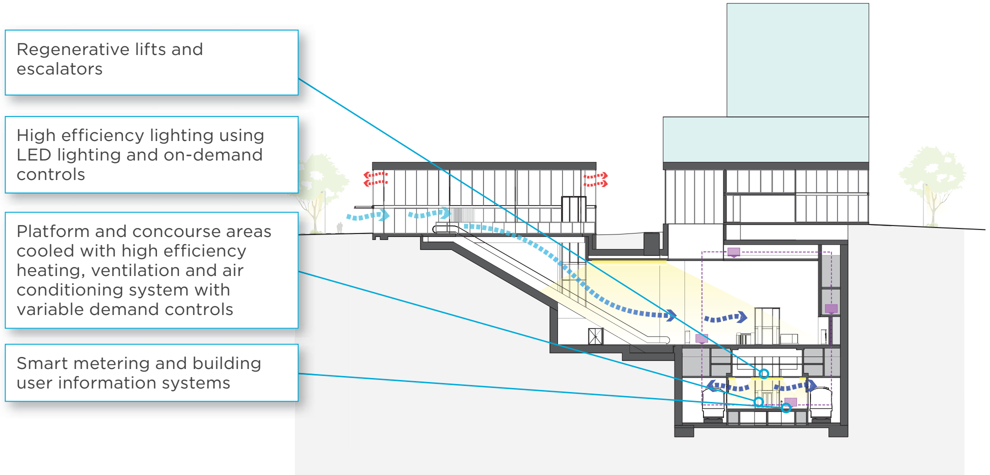


Figure 7 Long section highlighting sustainabiltiy opportunities

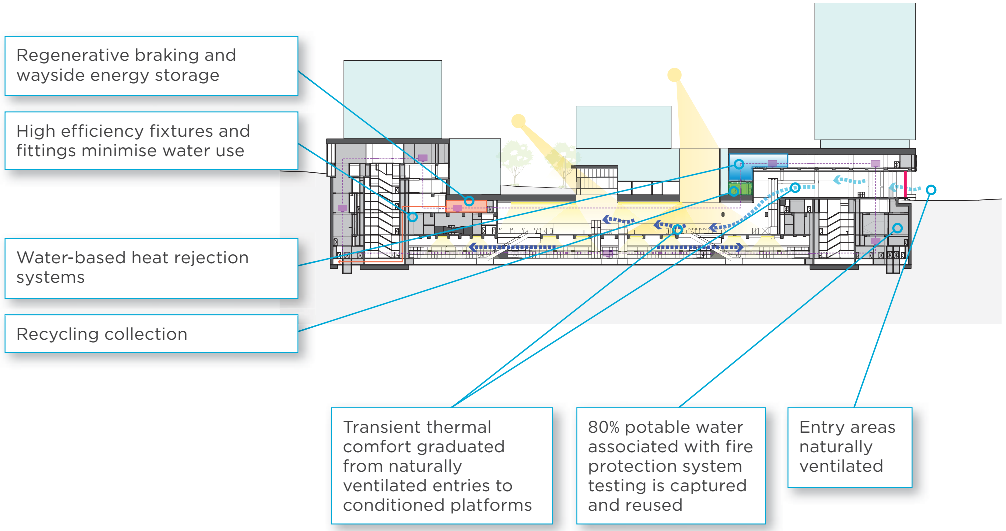
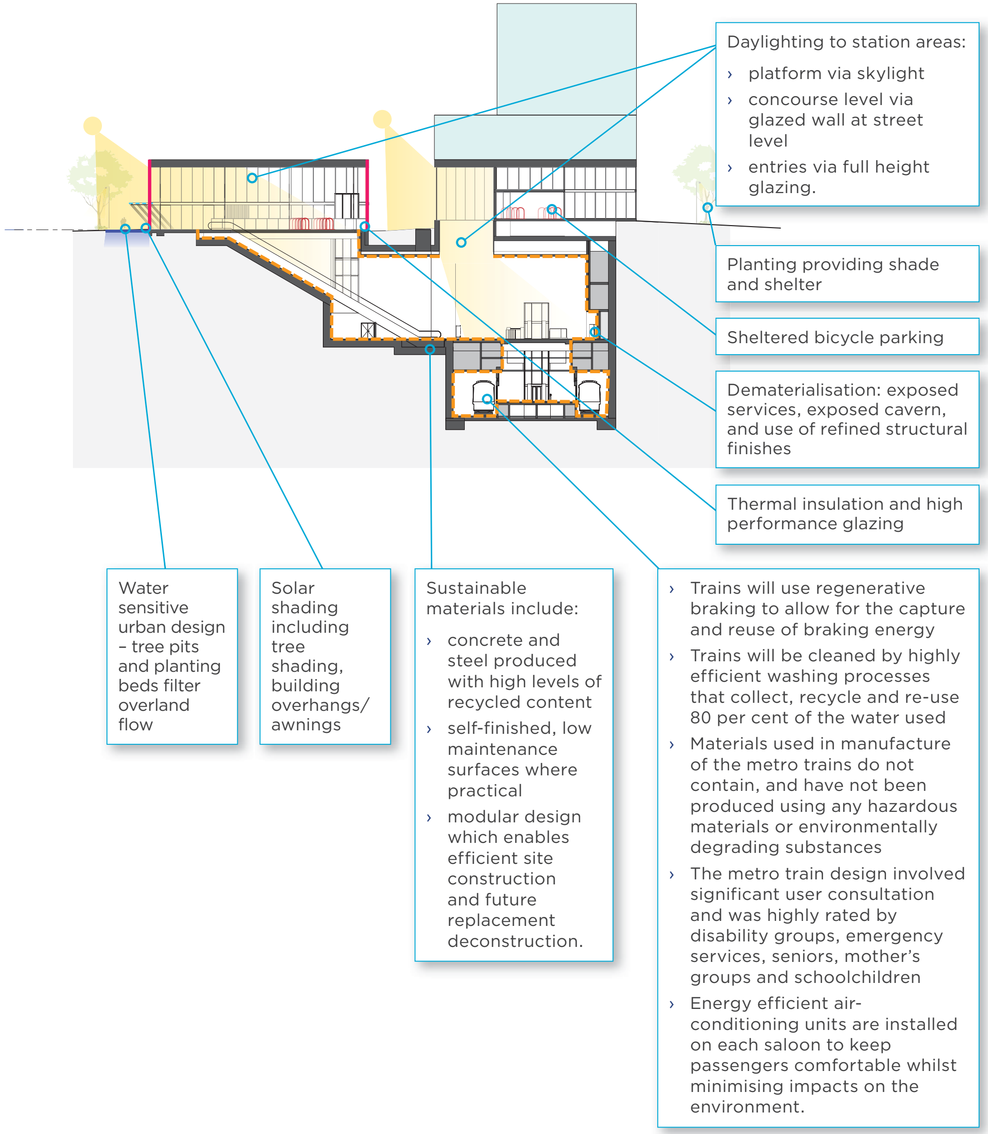


Figure 8 Cross section highlighting sustainabiltiy opportunities

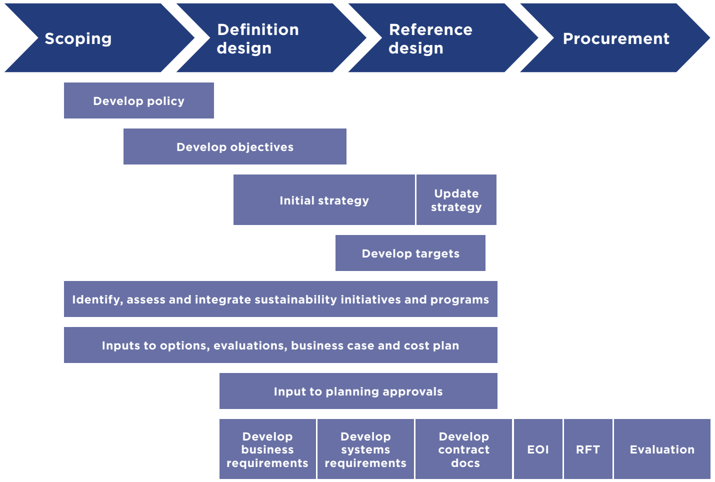


3.7 Strategy process and key activities

The overall process and key activities which have been undertaken to achieve the sustainability objectives, targets and initiatives for the Project components, through to the early procurement stage, are illustrated in Figure 9.

The next steps in implementation are described in Section 4.

Figure 9 Early implementation activities for individual project components of the City & Southwest Project



National Aborigines and Islanders Day Observance Committee (NAIDOC) Week celebrations at Sydney Metro Community Information Centre, Castle Hill, July 2016

3.8 Relationships with other strategies and frameworks

The Sydney Metro Integrated Performance Framework sets out a range of strategic program objectives for Sydney Metro. This Sustainability Strategy aligns with the strategic program objectives, as described in Appendix B

As previously outlined in Section 3.2 and Figure 3, there are some elements that while they form part of the broader definition of sustainability, are not the focus of this strategy. These elements are being delivered by other Sydney Metro teams and their respective objectives and initiatives are addressed in other strategies and plans, including:

› Sydney Metro Heritage Strategy
› Sydney Metro Overarching Community and Communications Strategy
› Sydney Metro City & Southwest Construction Noise and Vibration Strategy
› Sydney Metro Construction and Environmental Management Framework
› Sydney Metro Product Strategy
› Sydney Metro Program Safety Assurance Plan.

Workforce development has traditionally formed part of Sydney Metro's overall sustainability strategy's objectives and targets. These are now reflected in the Sydney Metro City & Southwest Workforce Development and Industry Participation Strategy (a separate document). The strategy sets a vision, objectives and initiatives relating to workforce development to reflect industry skills requirements, local demographics, regulatory drivers and wider government priorities around skill, employment, diversity and business growth.

Benefits from the implementation of the Sydney Metro City & Southwest Workforce Development and Industry Participation Strategy include:

› increased availability of skills and capacity, supporting Project delivery within a value-for-money approach
› socio-economic benefits for local communities and individuals
› development of intellectual capital through skilling, reskilling and upskilling local workers
› providing better employment options for local under-represented groups including Aboriginal people, young people and women
› increased collaboration with industry partners
› increased global competiveness of Australia's enterprises
› management of risks around providing local jobs as part of the project.

Further information on the Sydney Metro City & Southwest Workforce Development and Industry Participation Strategy is provided in Appendix O.

4 IMPLEMENTATION

4.1 Roles and responsibilities

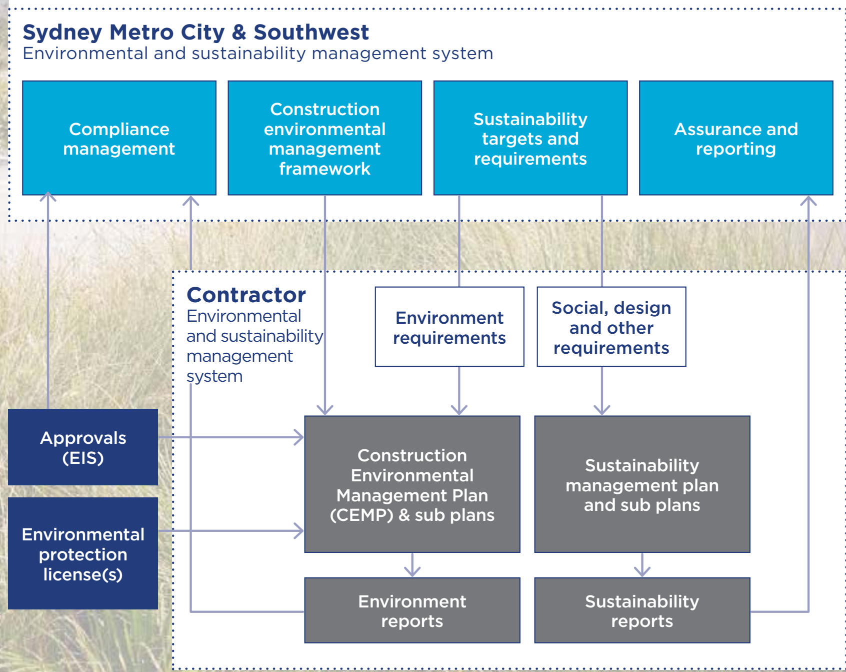
The responsibility for ensuring sustainability outcomes extends well beyond the Sydney Metro sustainability team to other work streams, functional groups, the Project Executive and contractors. Whether it is ownership of targets, or promotion of benefits and outcomes, sustainability is integrated across the team and is a shared responsibility.

4.2 Ensuring compliance – overarching management systems

The Environment & Sustainability Policy and Strategy has been integrated into the Environmental and Sustainability Management System (E&SMS), outlined in Figure 10. This figure also shows relationship between key documents within the Sydney Metro E&SMS and the Principal Contractor's E&SMS. Notably:

- the Construction Environment Management Plan (CEMP) and sub plans will capture the construction environmental requirements emerging from the EISs and subsequent planning approvals and this strategy
- the Sustainability Management Plans will capture governance and design requirements as well as social sustainability initiatives required by this strategy and contract requirements. These plans will vary in scope across different delivery packages
- progress against sustainability objectives and targets will be tracked through regular sustainability reporting over the delivery period. Future design changes may affect our ability to meet all targets. If a target has not been met, commentary will be provided.

Figure 10 Sydney Metro City & Southwest Environment and Sustainability Management System



Bioretention basin in commuter car park at Edmondson Park

Inside Sydney Metro's life-size train model

APPENDIX A
CONSISTENCY WITH RELEVANT PLANNING APPROVALS

The Chatswood to Sydenham Conditions of Approval (CoA), revised mitigation measures and revised environmental outcomes relating to sustainability and where they are addressed to demonstrate compliance are outlined in Tables A1 and A2.

Updated versions of this Strategy will reflect compliance with planning approvals which are obtained for other portions of the Project as they become available.

Table A1 Consistency with the Chatswood to Sydenham CoAs and revised mitigation measures and environmental outcomes

Ref	Condition/commitment	Where addressed in this Strategy
Condition of Approval – Infrastructure approval SSI 15_7400 (9 January 2017)		
E71	The proponent must seek to achieve a best practice level of performance for the CSSI using market leading sustainability ratings tools (including a minimum 'Design' and 'As built' rating score of 65 using the Infrastructure Sustainability Council of Australia infrastructure rating tool, or an equivalent level of performance using a demonstrated equivalent rating tool).	Table 2 – Governance theme and Appendix C
E72	The Proponent must prepare a Sustainability Strategy to be submitted to the Secretary within six (6) months of the date of this approval, or within another timeframe agreed with the Secretary, which must be implemented throughout design, construction and operation of the CSSI. The Sustainability Strategy must include:	This Strategy & Appendices
	(a) details of the sustainability objectives and targets for the design, delivery and operation of the CSSI	Section 3 and Appendices C–N
	(b) details of the sustainability initiatives which will be investigated and / or implemented (c) a description of how the strategy will be implemented for the CSSI.	Section 6 and Appendices C–N
E73	Opportunities to reduce operational greenhouse gas emissions must be investigated during detailed design. The sustainability initiatives identified must be implemented, reviewed and updated regularly throughout design development and construction, and annually during operation.	Table 2 – Carbon & Energy Management theme and Appendix D
E74	The Proponent must fully offset the greenhouse gas emissions associated with consumption of electricity during operation of the CSSI.	Table 2 – Carbon & Energy Management theme and Appendix D
E101	Before commencement of permanent built surface works and/ or landscaping, the Proponent must prepare Station Design and Precinct Plans (SDPP) for each station.....Each SDPP must include, but not be limited to: (a) identification of specific design objectives, principles and standards based on – ...v. sustainable design and maintenance...	This Strategy & Appendices outline applicable objectives, principles and standards, and will inform the SDPPs

Ref	Condition/commitment	Where addressed in this Strategy
Revised environmental mitigation measures – Sydney Metro Chatswood to Sydenham Submission and Preferred Infrastructure Report (October, 2016)		
Construction		
SUS1	Sustainability initiatives would be incorporated into the detailed design and construction of the project to support the achievement of the project sustainability objectives.	Appendix C
SUS2	A best-practice level of performance would be achieved using market leading sustainability rating tools during design and construction.	Table 2 – Governance theme and Appendix C
SUS3	A workforce development and industry participation strategy would be developed and implemented during construction.	Section 4
SUS4	Climate change risk treatments would be incorporated into the detailed design of the project including: › ensuring that adequate flood modelling is carried out and integrated with design. › testing the sensitivity of air-conditioning systems to increased temperatures, and identify potential additional capacity of air-conditioning systems that may be required within the life of the project, with a view to safeguarding space if required. › testing the sensitivity of ventilation systems to increased temperatures and provide adequate capacity.	Table 2 – Climate change resilience theme and Appendix F
SUS5	An iterative process of greenhouse gas assessments and design refinements would be carried out during detailed design and construction to identify opportunities to minimise greenhouse gas emissions. Performance would be measured in terms of a percentage reduction in greenhouse gas emissions from a defined reference footprint.	Table 2 – Carbon & Energy theme and Appendix D
SUS6	25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction would be offset.	Table 2 – Carbon & Energy Management theme and Appendix D
WM2	100 per cent of spoil that can be reused would be beneficially reused in accordance with the project spoil reuse hierarchy.	Table 2 – Resources – Waste & Materials theme
WM3	A recycling target of at least 90 per cent would be adopted for the Project.	Table 2 – Resources – Waste & Materials theme and Appendix H
Operation		
SUS7	Sustainability initiatives would be incorporated into the operation of the Project to support the achievement of the project sustainability objectives.	Appendix C
SUS8	Periodic review of climate change risks would be carried out to ensure ongoing resilience to the impacts of climate change.	Appendix F
SUS9	A workforce development and industry participation strategy would be developed and implemented during operation.	Section 4
SUS10	100 per cent of the greenhouse gas emissions associated with consumption of electricity during operation would be offset.	Table 2 – Carbon & Energy Management theme and Appendix D

Table A2 Consistency with the Chatswood to Sydenham EIS environmental performance outcomes

Relevant Secretary's environmental assessment requirements desired performance outcomes	Environmental performance outcome	Where addressed in this Strategy
Sustainability		
Sustainability The project reduces the NSW Government's operating costs and ensures the effective and efficient use of resources. Conservation of natural resources is maximised.	The project would be carried out in accordance with the Sydney Metro City & Southwest Environment and Sustainability Policy.	Section 3
	25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction would be offset.	Table 2 – Carbon & Energy Management theme and Appendix D
	100 per cent of the greenhouse gas emissions associated with consumption of electricity during operation would be offset.	Table 2 – Carbon Energy Management theme and Appendix D
Non-Aboriginal heritage		
Heritage The design, construction and operation of the project facilitates, to the greatest extent possible, the long term protection, conservation and management of the heritage significance of items of environmental heritage and Aboriginal objects and places.	The project would be sympathetic to heritage items and, where feasible and reasonable, avoid and minimise impacts to non-Aboriginal heritage items and archaeology.	Table 2 – Heritage Conservation theme and Appendix J
The design, construction and operation of the project avoids or minimises impacts, to the greatest extent possible, on the heritage significance of environmental heritage and Aboriginal objects and places.	The design of the project would reflect the input of an independent heritage architect, relevant stakeholders and the design review panel.	Appendix J
Aboriginal heritage		
Heritage The design, construction and operation of the project facilitates, to the greatest extent possible, the long term protection, conservation and management of the heritage significance of items of environmental heritage and Aboriginal objects and places.	The project would be sympathetic to heritage items and, where feasible and reasonable, avoid and minimise impacts to Aboriginal heritage items and archaeology.	Table 2 – Heritage Conservation theme and Appendix J
The design, construction and operation of the project avoids or minimises impacts, to the greatest extent possible, on the heritage significance of environmental heritage and Aboriginal objects and places.	The design of the project would reflect the input of an independent heritage architect, relevant stakeholders and the design review panel.	Appendix J
Social impacts and community facilities		
Socio-economic, land use and property The project minimises adverse social and economic impacts and capitalises on opportunities potentially available to affected communities.	The project would avoid long-term impacts (during operation) on the availability and quality of public open space and community facilities.	Appendix L
The project minimises impacts to property and business and achieves appropriate integration with adjoining land uses, including maintenance of appropriate access to properties and community facilities, and minimisation of displacement of existing land use activities, dwellings and infrastructure.	The project, during operation, would help to improve access to local facilities, services and destinations, supporting opportunities for community interaction.	Table 2 – Community Benefit theme and Appendix L
Biodiversity		
Biodiversity The project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity.	The biodiversity outcome would be consistent with the Framework for Biodiversity Assessment.	Appendix I
Offsets and/or supplementary measures are assured which are equivalent to any remaining impacts of project construction and operation.	The project would minimise impacts to biodiversity.	Table 2 – Biodiversity theme and Appendix I
Waste management		
All wastes generated during the construction and operation of the project are effectively stored, handled, treated, reused, recycled and/or disposed of lawfully and in a manner that protects environmental values.	All waste would be assessed, classified, managed and disposed of in accordance with the NSW Waste Classification Guidelines.	Appendix H
	100 per cent of spoil that can be reused would be beneficially reused in accordance with the Project spoil reuse hierarchy.	Table 2 – Resources – Waste & Materials theme and Appendix H
	A recycling target of at least 90 per cent would be adopted for the construction of the project.	Table 2 – Resources – Waste & Materials theme and Appendix H

APPENDIX B
INPUTS TO THE SUSTAINABILITY FRAMEWORK

Regulations and policy drivers

The City & Southwest sustainability strategy responds to, and aligns with, a number of regulatory and project drivers, outlined in Table B1.

Table B1 Regulatory and Project drivers for the City & Southwest Sustainability Strategy

Driver	Description
Regulatory drivers	
***Environmental Planning and Assessment Act 1979* (NSW)**	The EP&A Act objectives encourage Ecological Sustainable Development (ESD). The EP&A Act recognises that ESD requires the effective integration of economic and environmental considerations into decision making processes. There are four main principles supporting the achievement of ESD: › precautionary principle › intergenerational equity › conservation of biological diversity and ecological integrity › improved valuation and pricing of environmental resources.
***Transport Administration Act 1988* (NSW)**	A common objective and service delivery priority of public transport agencies is 'To promote the delivery of transport services in an environmentally sustainable manner'.
***The National Greenhouse and Energy Reporting Act 2007* (NGER)**	The NGER Act outlines a mandatory national system for reporting greenhouse emissions, abatement actions and energy consumption. Under the NGER Act, the Project will have reporting obligations due to the anticipated energy demand.
Aboriginal Participation in Construction Guidelines (2007)	The Aboriginal Participation in Construction Guidelines (2007) (Guidelines) are 'aimed at supporting and encouraging more employment and business opportunities for Aboriginal people on government construction projects'. Under the Guidelines project specific Aboriginal participation targets and KPIs are set by Contractors. A plan must be prepared and progress monitored and reported on.
NSW 2021 – State Plan (2011)	NSW 2021 includes a number of targets to protect and restore priority land, vegetation and water habitats, protect local environments from pollution, increase renewable energy, minimise waste, encourage recycling and minimise impacts of climate change on local communities.
NSW Long Term Transport Master Plan (2012)	The Plan states that 'promoting sustainability and protecting the environment in our transport planning, decisions and projects' is a state-wide challenge that must be addressed. The Plan focuses on achieving the following environmental and sustainability objectives: › enhancing environmental and sustainability outcomes › minimising damage to our environment › adapting our transport infrastructure to be resilient (to climate change and natural disasters) › maintaining Sydney's air quality › reducing emissions and managing energy use.
Australia Jobs Act 2013	Industry to supply goods and services to the Project.
NSW Government Resource Efficiency Policy (2014)	The NSW Government Resource Efficiency Policy (2014) (Policy) aims to drive resource efficiency, with a focus on energy, water and waste, and reducing harmful air emissions. The Policy aims to ensure NSW Government agencies: › meet the challenge of rising costs for energy, water, clean air and waste management › use purchasing power to drive down the cost of resource-efficient technologies and services › show leadership by incorporating resource efficiency in decision-making. The policy includes specific measures, targets and minimum standards to drive resource efficiency.
NSW Waste Avoidance and Resource Recovery Strategy 2014–21 (2014)	The NSW Waste Avoidance and Resource Recovery Strategy 2014-21 (2014) (Strategy) provides a framework for waste management and aligns with the NSW Government's waste reforms in NSW 2021. The Strategy includes the following six key result areas: avoid and reduce waste generation, increase recycling, divert more waste from landfill, manage problem wastes better (including asbestos), reduce litter, and reduce illegal dumping.
Aboriginal Participation in Construction Policy (2015)	The Policy aims to 'increase the employment and education opportunities for Aboriginal people within the construction industry'. Under the Policy a percentage of the total estimated value of the contract (termed 'targeted project spend') must be directed to Aboriginal related employment and education activities, procurement of goods or services from recognised Aboriginal businesses or other programs. An Aboriginal Participation Plan must be prepared and published shortly after contract award. A Participation Report must be prepared and published (once construction is 90 per cent complete) describing how the Plan was implemented.
NSW Strategic Business Case Gateway	Sustainability indicators form a key component of the Gateway Review System. The Gateway Review is a NSW Government process that assesses the progress of projects against the following seven criteria service (including sustainability) to inform the procurement process.
Other frameworks and policies	
Transport Environment and Sustainability Policy Framework (2013)	The Framework was developed to establish a collective and coordinated approach to deliver the NSW Government's environmental and sustainability agenda across the transport sector. The Framework includes objectives, targets, measures and action plans to deliver positive environmental outcomes. The Framework has been developed to align with the State Plan 2021 and Transport Master Plan. The TfNSW sustainability aspiration is 'to provide a world class sustainable transport system that meets customer expectations and optimises economic development for NSW' (TfNSW Framework, 2013). A number of TfNSW sustainability guiding principles are outlined and have been used to guide the development of the sustainability objectives for The Project.
Sydney's Cycling Future, Cycling for everyday transport (2013)	Outlines how the NSW Government will 'improve the bicycle network and make sure that the needs of bike riders are built into the planning of new transport and infrastructure projects.' Sydney's Cycling Future provides the strategic and policy context, articulating: › [ensuring] that the needs of bike riders are built into the planning of new transport and infrastructure projects › Deliver bicycle infrastructure through major transport and development projects.'

Driver	Description
Sydney's Walking Future, Connecting people and places (2013)	The goal of Sydney's Walking Future, Connecting people and places (2013) is to 'get people in Sydney walking more through actions that make it a more convenient, better connected and safer mode of transport.'
Sydney's Bus Future, Simpler, faster, better bus services (2013)	Sets out how essential improvements to the bus network will be implemented to meet changing customer needs, including being able to access major centres outside the Sydney CBD.
NSW Renewable Energy Action Plan (2013)	The REAP intends to position NSW as the clean energy State of Australia – attracting investment, building a clean energy knowledge industry and creating jobs, whilst reducing the State's contribution to greenhouse gas (GHG) emission.
NSW Procurement Policy Framework 2014	Sets out mandatory requirements and guidance on sustainable procurement practices for NSW government agencies.
TfNSW Environment & Sustainability Policy (2015)	TfNSW's commitment to delivering transport services, projects, operations and programs in a manner that balances economic, environmental and social issues to ensure a sustainable transport system for NSW.
NSW Premier's announcement – 1000 apprentices	June 2014 announcement that "Under the NSW Government's procurement process for major infrastructure projects, we will set minimum requirements for apprenticeships on a project-by-project basis and ensure bidders spell out how they will leave a lasting skills dividend for local communities...These actions will create at least 1,000 new apprenticeship positions during the delivery of our infrastructure program.."
TfNSW Diversity and Inclusion Policy	The policy embraces equal employment opportunity which is pivotal to addressing employment disadvantage for diverse groups including but not limited to: women, Aboriginal people, people with a disability and people from culturally and linguistically diverse backgrounds.
Infrastructure Skills Legacy Program & Demonstration pilot	The Program will support the Premier's state priority to create jobs, together with a focussed commitment to grow skills and jobs through infrastructure investment. Sydney Metro is in the final stages of signing a MoU with NSW Department of Industry, Skills and Regional Development to become a demonstration pilot project as part of the program. This will secure funding for accredited training across the Project.
NSW Procurement – PBD-2016-02 Construction apprenticeships	The Procurement directive ensures skills development goals are established for all relevant government construction projects. The NSW Procurement Board requires all NSW projects identify a target for the engagement of apprentices or trainees for every construction contract valued over $10 million.
NSW Procurement – Construction Skills Development Plan	NSW Procurement Board requires NSW Government agencies with a major construction program to publish and maintain a Construction Skills Development Plan. This plan will identify skills needs arising from the agency's forward construction program. The plan will also explain the strategies or programs that the agency is using to address skills shortages.

Driver	Description
Project drivers	
City & Southwest Environment & Sustainability Policy (April 2016)	Project commitment to sustainable outcomes.
NWRL Sustainability Strategy (2012)	Benchmark for Sydney Metro's approach to sustainability.
City & Southwest Business Requirements	Reflect the sustainability objectives for the Project.
Endorsed approach to workforce development	The workforce development objectives and approach to implementation, including investigating specific programs, was endorsed by the People and Teams Executive Subcommittee.

TfNSW sustainability guiding principles

TfNSW's Transport Environment and Sustainability Policy Framework (June 2013) outlines six guiding principles guide and support TfNSW's decision making to deliver improved sustainability performance. These were considered in the development of this Strategy and the Project's sustainability objectives and include:

- **Consider whole-of-life costing:** When comparing investment decisions, TfNSW will consider the potential future costs such as operating costs, environmental and social costs as well as the initial capital expenditure in the assessment of the best option. This will ensure the true cost of the asset over its life time is fully considered.
- **Integrated planning:** Transport will work with its partners to develop integrated transport services and infrastructure that meet the existing and future requirements of its customers.
- **Encourage innovation:** Transport will work with its partners to drive continual improvement in the environmental performance of transport infrastructure and services during the planning, design, building and operating. This will help to ensure we maintain best practice and deliver value for money.
- **Customer focus:** Transport will consider the needs and expectations of its customers in the planning, design, building and operation of transport services and infrastructure. The customer is at the centre of our decision making.
- **Engage our partners:** The successful delivery of transport services and infrastructure is dependent on the performance of TfNSW's partners. TfNSW aims to develop strong and trusted relationships with its partners to ensure transport services and infrastructure meets the expectations of its stakeholders – value for money, innovation and environmental performance.
- **Measure and report on performance:** To drive continual improve in transport services and infrastructure, Transport will measure and report its progress against the sustainability indicators and targets. It will report internally and to its external stakeholders on a regular basis.

Sydney Metro Integrated Performance Framework

Sydney Metro's mission is to deliver Sydney a connected metro service, providing more choice to customers and opportunities for our communities now and into the future. The Integrated Performance Framework (Figure B1) defines the overarching Sydney Metro strategic objectives.

This sustainability strategy supports the achievement of the following specific strategic objectives:

- A successful delivery
  - We will strive to exceed Government commitments and community expectations.
- A world class metro
  - We will establish vibrant and accessible hubs which unlock the potential of surrounding precincts, and make our global city more productive, connected, sustainable and liveable.
- A transformative legacy
  - We will use this once-in-a-generation investment to shape a legacy that makes a positive difference to people's lives.
  - We are game-changers, resetting the standard for infrastructure delivery and developing new and best-practice skills, technologies, and systems.

Figure B1 Integrated Performance Framework

Our safety commitment

Safety is our first, and highest, priority
Promote the highest standards of safety and wellbeing
Safety and wellbeing is everyone's responsibility

A successful delivery

We will strive to exceed Government commitments and community expectations

We continually learn, improve and mature our delivery model

By reputation and practice, we will establish ourselves as a trusted partner

A world class metro

We will grow a customer base that highly values the metro experience

We will establish vibrant and accessible hubs which unlock the potential of surrounding precincts, and make our global city more productive, connected, sustainable and liveable

We explore and pursue every opportunity

A transformative legacy

We will use this once-in-a-generation investment to shape a legacy that makes a positive difference to people's lives

We are game changers, resetting the standard for infrastructure delivery and developing new and best-practice skills, technologies, and systems

Our ways of working

We understand our roles and are accountable for out outcomes
We are recognised and respected as an authentic values-based team
We rise to challenges, embrace change and are open to creative solutions
We invest in our people, and promote a diverse and inclusive workforce, knowing that together we can achieve great things
We excel through strong, collaborative and robust relationships with a wide network of stakeholders

Lessons learnt from Sydney Metro Northwest

Recommendations and lessons learnt from the implementation of the Sydney Metro Northwest sustainability strategy, targets and requirements which are relevant to strategic sustainability considerations are as follows:

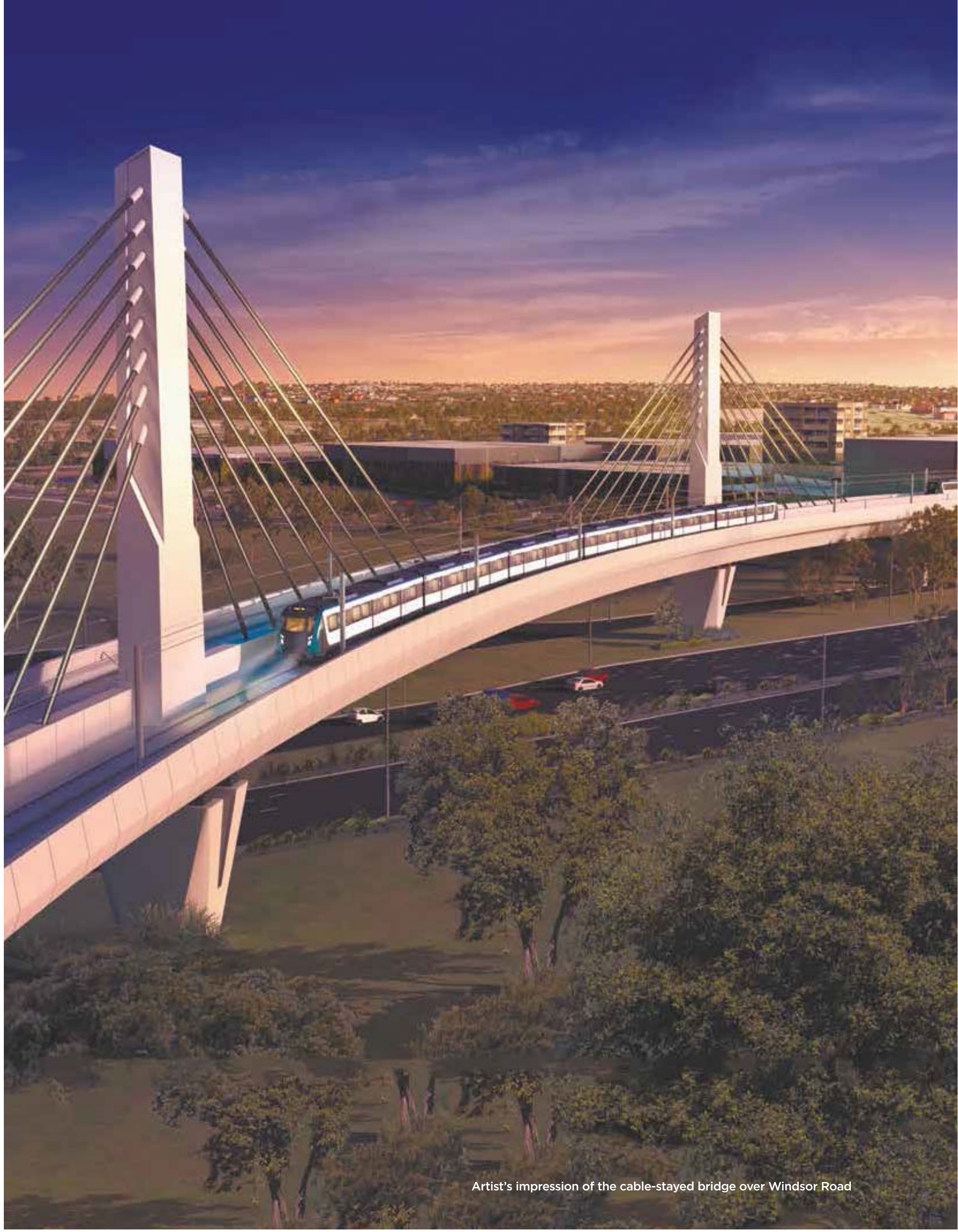
- the sustainability targets and contract requirements established for Sydney Metro Northwest are achievable and to date have been successfully delivered by Sydney Metro Northwest contractors
- rating tools have been useful in focussing contractor teams, and communicating performance to broader stakeholders
- dedicated contractor sustainability resources with appropriate qualifications and experience (rather than shared environmental management resources) will provide the best opportunity to achieve good outcomes
- adequate sustainability resourcing on the client side (within Sydney Metro, implementation groups, contract managers) and within the independent certifier, is an important consideration
- best outcomes are achieved when the contractor executive team is active in, and responsible for, getting results
- incentive payments can be a useful tools for achieving outcomes
- requiring contractors to comply with layers of ratings and contract requirements can lead to ambiguity and conflicts, and should be streamlined and simplified where possible
- contractors will not deliver against requirements or targets which are not measurable (e.g. 'enhance' community benefits)
- construction and operational targets should be separated for clarity
- additional focus is required in the procurement area. Sustainable outcomes will not be achieved if requirements are not passed down the supply chain
- human rights / ethical sourcing issues should be considered where equipment and materials are sourced from developing countries.

Additional lessons learned in the workforce development and industry participation area have been documented in that Strategy the Workforce Development and Industry Participation Strategy.

Best practice benchmarking

A Sustainability Benchmarking Report (February 2015) was developed to review recent and current best practice in the sustainable design of national and international rail and infrastructure projects. The following case studies were reviewed to inform the project team of industry best practice sustainability initiatives and performance targets:

- North West Rail Link – Sydney, Australia
- Sydney Port Botany Expansion, Habitat Restoration
- Sydney Inner West Light Rail – Greenway
- Sydney South West Rail Link Leppington Station – Green Walls
- Barangaroo South, Seawater Cooling
- Goulburn Valley Highway, Aboriginal Heritage
- Goulburn Valley Highway, Aboriginal Heritage
- Qld Northern Busway Alliance, Aboriginal Heritage
- Gold Coast Light Rail – Queensland, Australia
- Gateway WA – Perth, Australia
- Westgate Freeway, E-Crete (Geopolymer Concrete)
- South Morang Rail Extension Project, bike and pedestrian connectivity
- TriMet Portland – USA
- New York Metropolitan Transit Agency – USA
- Tarrant Regional Water District Line J – Texas, USA
- LA Metro, Trackside Energy Storage
- Hong Kong Metro, Trackside Energy Storage
- Leeds Northern Rail – Cyclepoint
- London Heathrow Airport, 'Pavegen' Footfall Energy Generation
- London Farringdon Station Redevelopment, Green Roof
- London Olympics 2012 Development – UK
- Network Rail – UK.


Artist's impression of the cable-stayed bridge over Windsor Road

APPENDIX C GOVERNANCE

OBJECTIVES:

- Demonstrate leadership by embedding sustainability objectives into decision making.
- Demonstrate a high level of performance against objectives and appropriate benchmarks.
- Be accountable and report publicly on performance.

C1.1 Current position

Sydney Metro is committed to embedding good governance in all processes for the Project and providing the resources required to ensure effective implementation of those practices.

Sustainability governance activities include ensuring there are appropriate levels of resources and budget for key personnel to champion sustainability throughout the project team, embedding sustainability within decision-making frameworks and project management systems, engaging internal and external stakeholders, aligning the Project to achieve best-practice sustainability outcomes, implementing an assurance process to track and report against sustainability targets, and capturing and applying lessons learned from the Sydney Metro Northwest project to ensure continual improvement.

The main components of the sustainability governance framework are:

› **This strategy** lays the foundation for addressing social and environmental issues for City & Southwest by clearly articulating the objectives and targets for the Project.

› **The Environment & Sustainability policy** (April 2016) articulates Sydney Metro's position on sustainability and the environment of the Project and provides a point of reference for internal and external stakeholders.

› **Rating tools** applicable to the Project have been adopted where considered to drive best practice sustainability outcomes, whilst providing clarity to the project team, market recognition, and third party verified assurance. The priority has been to develop a streamlined outcomes-focussed approach to applying sustainability rating tools on the Project which minimises duplication and is tailored to the scope of each of the delivery contracts.

› Sydney Metro will develop an **assurance framework** and process to track and report against targets for the Project. The Sydney Metro Environment & Sustainability Management Manual, (which is part of the Integrated Management System for Sydney Metro), sets out roles and responsibilities, processes and procedures for driving sustainable outcomes, monitoring and reporting performance, and continual improvement.

C1.2 Future expectations

Sydney Metro will require delivery contractors to achieve ratings and/or adopt initiatives outlined in the following available sustainability rating tools:

› Infrastructure Sustainability Council of Australia (ISCA) Infrastructure Sustainability (IS) rating scheme

› Green Building Council of Australia (GBCA) Green Star design and as built rating scheme

› TfNSW's Sustainable Design Guidelines (SDGs).

The application of rating tools to specific contracts is dependent on the scope and dollar value of each of the contract packages.

The IS rating scheme is most applicable to the infrastructure portions of the Project. Sydney Metro will register the Project under the 'Program' ratings system, and then have contractors seek ratings for their individual delivery packages (where specified in contracts). Sydney Metro Northwest civil works contractors were required to achieve an IS 65 ('Excellent') score. The tunnelling contractors achieved a score of 92, and the viaduct contractors are on track to also exceed the 65 benchmark.

The GBCA Green Star rating scheme is applicable to buildings. Sydney Metro will be using Green Star to drive sustainable design outcomes for new underground stations.

The TfNSW SDGs comprise a scoring system for sustainable design and construction of rail projects. The SDGs are currently being reviewed and updated by the TfNSW Infrastructure and Services Division, with a new version (Version 4) scheduled for release in mid-2017. To streamline ratings requirements, Sydney Metro will not require all contractors to achieve SDGs ratings. Instead, relevant elements of the emerging updated SDGs will be embedded into contracts where appropriate.

Where ratings are specified, contractors will be required to achieve a high level of attainment. The specific level has been tested by the Sydney Metro design team and reflects the optimum level of performance which maximises both sustainability outcomes and value for money.

Sydney Metro will establish appropriate resources, funding and systems within the project team to monitor and track achievement against sustainability performance targets, and review performance on a regular basis (annually at a minimum).

TARGETS:

- **A high level of attainment (minimum ISCA IS Rating of 65 'Excellent') for relevant infrastructure.**
- **5 Star Green Star ratings for relevant buildings.**
- **Align with a high rating using the TfNSW Sustainable Design Guidelines.**

Objective	Key example initiatives
Demonstrate a high level of performance against objectives and appropriate benchmarks	› Develop performance targets across all sustainability themes. › Achieve a best practice level of performance using market leading sustainability rating tools (ISCA, Green Star, SDGs or equivalent) during design, construction and operation.
Demonstrate leadership by embedding sustainability objectives into decision making	› Ensure the project decision making framework includes sustainability criteria (environment and community). › Implement incentives such as Key Performance Indicators and tender assessment criteria. › Develop industry partnering to promote sustainable development (e.g. with industry bodies, educational institutions and the community). › Promote innovation.
Be accountable and report publicly on performance	› Use an assurance framework and reporting system to assist Sydney Metro and contractors in reliably reporting against sustainability targets. › Monitor sustainability performance, and provide public sustainability reports.

Artist's impression of an underground station at Central Station

APPENDIX D
CARBON AND ENERGY MANAGEMENT

OBJECTIVES:

- Improve the shift toward lower carbon transport.
- Reduce energy use and carbon emissions during construction.
- Reduce energy use and carbon emissions during operations.
- Support innovative and cost effective approaches to energy efficiency, low-carbon/ renewable energy sources and energy procurement.

D1.1 Current position

Construction and operation of a new metro system is energy intensive and has the potential to result in the emission of significant quantities of greenhouse gases (GHG) associated with fuel and electricity use, and contribute to climate change. Sydney Metro will identify and implement best practice approaches to minimising and managing energy use and carbon emissions, which are economically feasible and environmentally responsible, including sourcing renewable energy for both construction and operational purposes.

Estimates of electricity consumption and GHG (or carbon) emissions associated with the Project are summarised in Table D1 as follows:

Table D1 Estimated electricity consumption and carbon emissions

Phase	Electricity consumption (GWh) (1)	Carbon emissions (kilotonnes CO_2-e) (1)
Construction	130	1,020
Operation	221	219

Notes: (1) These estimates were developed at the initial feasibility stage (May 2017), and are not yet complete. As such they should be considered indicative, and will be updated as the Project progresses. Due to data gaps, construction estimates are likely to be underestimated.

For context, construction phase emissions are anticipated to be equivalent to the emissions from approximately 81,600 households for one year (assuming household emissions of 12.5 tonnes CO_2e per year), and operations phase emissions will be equivalent to those from approximately 17,500 households.

The main contributors to construction-related emissions are:

› combustion of fuel in construction plant, equipment and vehicles and at construction sites – Scope 1 emissions[1]

› electricity consumption for the tunnel boring machines – Scope 2 emissions[2]

› embodied emissions in key construction materials, principally cement and steel – Scope 3 emissions[3].

[1] Scope 1 emissions, also called 'direct emissions' are emissions generated directly by a project.
[2] Scope 2 emissions, also referred to as "indirect emissions" are generated outside of a project's boundaries to provide energy to the project.
[3] Scope 3 emissions include all indirect emissions (not included in Scope 2) due to upstream or downstream activities.

The operations phase estimate includes GHG emissions associated with operational and maintenance activities over the life cycle of the Project including:

› metro trains

› station facilities

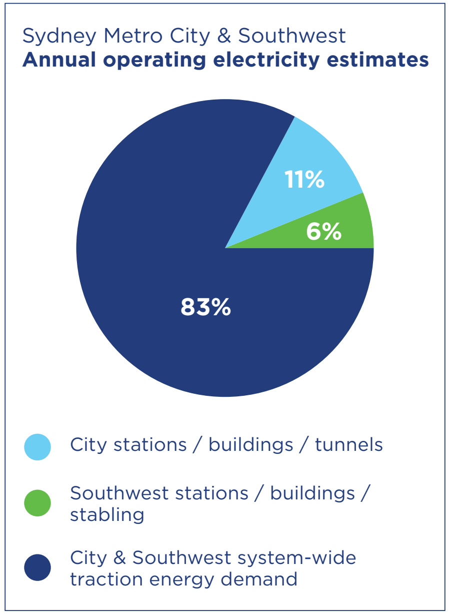
› signalling and communications

› tunnel ventilation

› water treatment plants.

The most significant contributor to operational GHG emissions is electricity consumption. At the initial feasibility stage, traction energy was estimated to represent approximately 83 per cent of the operational electricity consumption (refer to Figure D1.

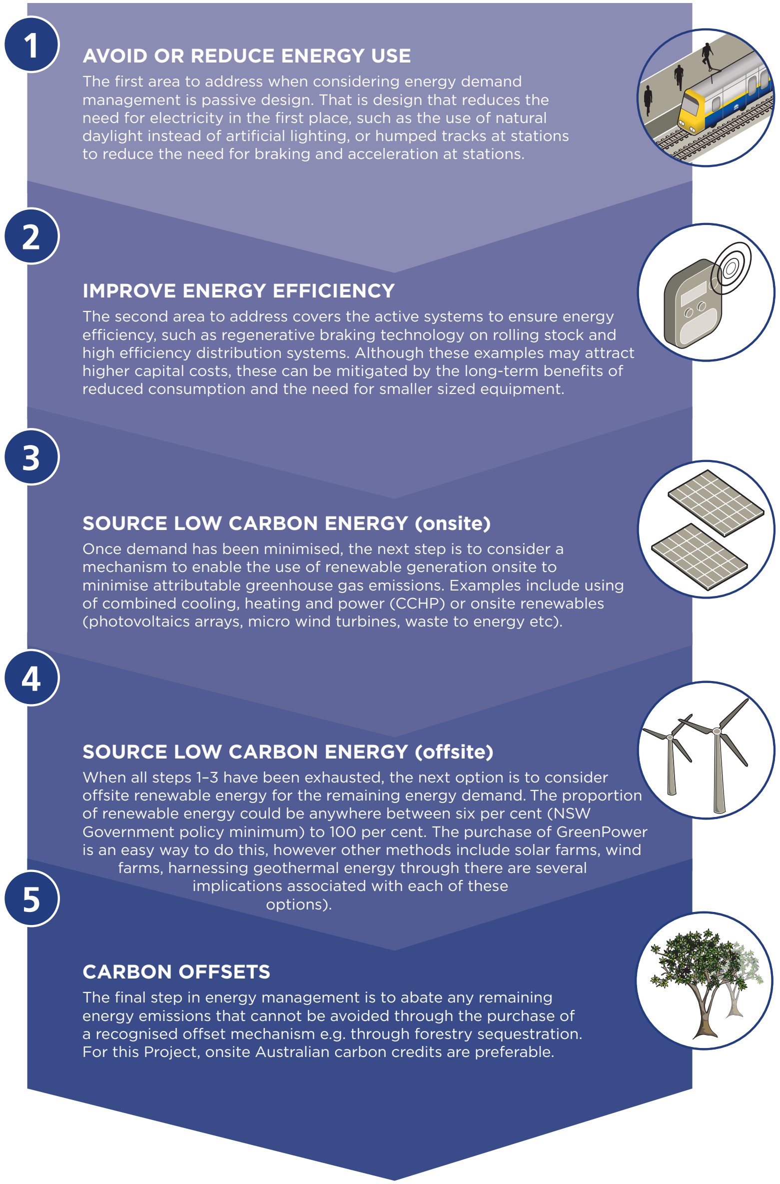
Figure D1 Sydney Metro City & Southwest operational electricity consumption estimates



Wind turbine photo courtesy of Gavin Mills

In identifying and implementing energy efficiency and GHG reduction opportunities, Sydney Metro adopts the energy management hierarchy illustrated in Figure D2.

Figure D2 Energy management hierarchy



Design

Key energy efficiency and GHG reduction measures adopted at the initial feasibility stage of the Project include:

- Receptivity of the traction power system has been maximised – a minimum of 32 per cent of the net traction energy consumption per round trip can be reduced through regenerative braking.
- Space for wayside energy storage safeguarded.
- Energy efficient vertical transport, high performance thermal insulation and glazing, energy efficient heating, ventilation and air conditioning systems, LED lighting, smart metering and building user information systems at all stations.
- At city stations, transient thermal comfort is provided for in-line with station function, graduating from naturally ventilated entries to fully conditioned platforms. City stations maximise daylight penetration to concourse levels, complementing energy efficient lighting systems.
- Initial feasibility assessments indicate that a 15 per cent improvement on National Construction Code BCA Section J minimum energy performance requirements can be achieved.
- Solar shading provided where possible including tree shading, building overhangs/ awnings, and external shading devices.
- Building integrated photovoltaics (PV) at above ground stations and Central Station to meet approximately 5 to 20 per cent of the annual electrical energy demand at southwest stations, and up to 20 per cent of the annual electricity demand at the new Central eastern concourse.
- Safeguarding for connection of the Sydney Metro Barangaroo Station to the Barangaroo Central chilled water network.

Technical and cost benefit analysis completed by the Project technical advisers has supported the development of energy and GHG reduction targets

Design phase initiatives will translate to energy savings during the operations phase.

Construction

Construction phase initiatives identified to be adopted during delivery include:

- using the TfNSW Carbon Estimate Reporting Tool (CERT) and relevant ISCA credits to set energy use and emission reduction targets
- using energy efficient construction practices, and temporary facilities
- offsetting 25 per cent of the electricity used during construction
- ensuring that major equipment is selected and operated for optimum energy efficiency, especially large equipment such as tunnel boring machines and road headers
- using modern vehicles, plant and equipment utilising technology that minimises carbon emissions, including hybrid technology where available
- encouraging workers to travel to and from construction sites using public transport
- prioritising local sourcing of materials where feasible.

Offset

During operation, Sydney Metro Northwest is committed to offset 100 per cent of the GHG emissions associated with operational electricity (approximately 134 GWh/year). This commitment is being progressed via the procurement of electricity from a new renewable energy project in NSW. Aside from significant GHG offsetting, this approach has the additional benefits of driving investment in renewable energy in NSW and delivering economic benefits to the local and state economies.

A similar commitment will be implemented for the Project.

D1.2 Future expectations

Sydney Metro will require delivery contractors to implement energy efficiency and carbon reduction initiatives in design and construction.

Further investigation of the following initiatives will be conducted in the next stage of the Project:

› wayside energy storage of energy generated from braking trains
› potential funding opportunities which may be available to facilitate energy efficiency upgrades (lighting, air conditioning, ventilation, lifts/escalators, power factor correction etc.) of southwest and Central stations which will be retained
› further analysis of costs and benefits of offsetting 100 per cent of carbon emissions associated with operation of the Project
› design development to fully integrate PV into new canopies at southwest stations and Central Station
› refinement of the incentive scheme to minimise electricity consumption during the operations phase
› opportunities for connection by Sydney Metro Barangaroo Station to the Barangaroo Central chilled water network.

TARGETS:

- **Achieve at least a 20 per cent reduction in carbon emissions associated with construction, when compared to business as usual.**
- **Offset 25 per cent of the electricity needs for the construction phase of the project.**
- **Achieve at least a 20 per cent reduction in carbon emissions associated with operations, when compared to business as usual.**
- **Maximise the capture and reuse of energy generated from braking trains.**
- **Design buildings (stations and stabling buildings) to achieve at least a 15 per cent improvement over performance requirements set out in Section J of the National Construction Code.**
- **Source 5–20 per cent of the low voltage electricity required at above ground stations from onsite renewable energy sources.**
- **Offset 100 per cent of the electricity needs for the operational phase of the project.**

Objective	Key example initiatives
Improve the shift toward lower carbon transport	› Optimise integration of the Project with the most sustainable access modes including walking, cycling and bus.
Reduce energy use and carbon emissions during construction	› Incorporate energy efficient construction equipment, methods, and practices. › Local sourcing of materials where feasible. › Use biodiesel and ethanol fuel. › Implement green travel plans. › Energy efficient site construction compounds. › Investigate and implement opportunities to use renewable energy (including small scale photovoltaics) during the construction phase. › Offset 25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction.
Reduce energy use and carbon emissions during operations	› Maximise reuse of energy recovered from the train braking system (regenerative braking). › Maximise passive design features including daylight, natural ventilation, and passive cooling. › Energy efficient ventilation, air conditioning, pumps, escalators, lifts and appliances. › Efficient lighting and lighting control systems. › Target energy consumption at least 15 per cent lower than minimum compliance with the National Construction Code. › Integrate renewable energy (photovoltaics) into new station canopies along the southwest. › Continual improvements using metering, monitoring and reporting to drive efficiency. › Ongoing investigation and implementation of energy efficiency initiatives in line with evolving technology.
Support innovative and cost effective approaches to energy efficiency, low-carbon / renewable energy sources and energy procurement	› Utilise wayside energy storage, renewable energy, and district cooling systems where feasible. › Offset 100 per cent of the greenhouse gas emissions associated with consumption of electricity during operation. › Explore funding opportunities for energy efficiency upgrades of Central and southwest stations.

Pedestrian and bicycle connections

APPENDIX E
ENVIRONMENTAL PERFORMANCE

OBJECTIVES:

- Reduce sources of pollution and optimise control at source to avoid environmental harm.
- Comply with environmental obligations outlined in applicable project planning approvals.

E1.1 Current position

As with any large infrastructure project, without appropriate management, the construction and operation of the Project has the potential to cause pollution impacts related to noise and vibration, air quality and water quality. Potential impacts include:

- noise and vibration impacts during construction
- noise and vibration impacts during operation
- dust and diesel emissions during construction
- internal air quality in buildings and stations during operation
- quality of discharge or stormwater runoff during construction and operation
- groundwater impacts during tunnelling
- accidental spills or incidents potentially impacting receiving waters, including Sydney Harbour
- light pollution impacts during construction and operations.

The Project's impacts are the subject of environmental impact statements as part of seeking planning approval for the Project. Measures required to prevent and mitigate impacts will be included as conditions of approval, and will be implemented on the Project.

Opportunities will be taken to improve stormwater quality and minimise runoff through the implementation of water sensitive urban design (WSUD). WSUD features have been integrated in design to date, and include allowance for planting of the onsite detention basin at the Northern Dive, and tree pits and planting beds to filter overland flow at stations. Water quality objectives have been established for WSUD features.

E1.2 Future expectations

Sydney Metro will proactively work with its contractors to maximise environmental protection and to minimise both environmental harm and disturbance to local communities and businesses. Contractors will be required to adhere to a Construction Environmental Management Framework and develop environmental management plans for the construction phase. Many of the contract packages will work under an Environmental Protection Licence regulated by the EPA, depending on the activities which are being conducted by the contractors.

Further opportunities will be explored to incorporate elements of WSUD into the design of the stations, their immediate environs and the above ground sections of the Project's alignment. Opportunities may include the implementation of grass or vegetated swales to capture stormwater drainage at all paved areas such as at-grade car parks and the stabling facility.

Sydney Metro will work with contractors to explore feasible methods of minimising emissions from diesel-fuelled construction equipment. In the first instance this will involve:

- contractors reporting on mobile non-road diesel plant and equipment engine conformity with relevant United States Environmental Protection Agency, European Union or equivalent emission standards and the fitting of any exhaust after-treatment devices
- encouraging contractors to identify new emission standards and apply these to diesel equipment and vehicles during construction

Contractors will also be required to minimise harmful emissions associated with finishes and fittings emissions, it is expected that all internal applications will have Volatile Organic Compounds (VOC) limits for paints, finishes, adhesives and sealants, and formaldehyde limits for all composite wood products.

TARGETS:

- **Zero major pollution incidents.**
- **New emission standards will be identified and applied to diesel equipment and vehicles during construction.**

Objective	Key example initiatives
Reduce sources of pollution and optimise control at source to avoid environmental harm	› Environmental Management Plans and Environmental Management Systems are in place prior to commencement of construction. › Early identification and management of existing soil and groundwater contamination which may be impacted by the Project. › Integrating water sensitive urban design solutions for storm water treatment. › Encouraging contractors to utilise equipment with pollution control devices to reduce emissions from mobile non-road diesel plant and equipment at source. › Including noise and air quality mitigation measures where appropriate. › Designing stations and temporary facilities to minimise light spill in accordance with standards. › VOC and formaldehyde limits for fittings and finishes.
Comply with environmental obligations outlined in applicable project planning approvals	› Compliance with planning approval conditions will be managed through the City & Southwest Compliance Tracking Program.

APPENDIX F
CLIMATE CHANGE RESILIENCE

OBJECTIVE:

- Infrastructure and operations will be resilient to the impacts of climate change.

F1.1 Current position

There is widespread scientific consensus that the effects of climate change will be significant. The CSIRO and NSW Office of Environment & Heritage (OEH) have undertaken considerable research into the predicted effects of climate change across Australia.

In order to reduce the vulnerability of the Project to climate change, a climate change risk assessment for the Project has been developed at the initial feasibility stage (August, 2016) and provides climate change projections, a climate change risk assessment and risk treatment measures (adaptation).

Climate change projections

Climate change projections used for the Project are presented in Table F1 and summarised below:

› Short term (2030) – project stages for this scenario include construction, operations and routine maintenance. By 2030 there will be approximately a 1.1°C increase in temperature, with increasing frequency of hot days over 35°C. Average rainfall may range from a 10 per cent decrease in spring to a 0.7 per cent increase in summer, with increased likelihood and intensity of extreme rainfall.

› Medium term (2060) – project stages for this scenario include operations, routine maintenance, major maintenance and replacement of assets and systems. By 2060, it is projected for there to be up to a 2.4 °C increase in temperature, with average rainfall ranging from an 11.3 per cent decrease in winter to 0.4 per cent decrease in summer.

› Long term (2090) – project stages for this scenario include operations, major maintenance and replacement of assets and systems. By 2090 up to 3.9°C increase in temperature, with increasing frequency of hot days over 35°C. Winter and spring rainfall patterns to vary widely, with increased likelihood and intensity of extreme rainfall.

Table F1 Summary of climate change projections

	Sydney Metro – City baseline (1986-2005)	Sydney Metro – Southwest baseline (1986-2005)	2030 (RCP8.5)	2060 (RCP8.5)	2090 (RPC8.5)
Temperature					
Annual	22.3	23.2	+1.2	+2.4	+3.9
Mean maximum temperatures (°C) – summer	26.1	27.8	+1.1	+2.0	+3.8
Mean minimum temperature (°C) – annual	14.4	12.0	+1.1	+2.4	+3.8
Days over 35°C – annual	3.5	8.9	+4	+11	Unknown
Rainfall					
Mean precipitation change (per cent) – annual	1335mm	1723mm	-6.1	-6.6	-7.9
Mean precipitation change (per cent) – spring	258mm	370mm	-9.7	-10.7	-18.5
Mean precipitation change (per cent) – summer	389mm	525mm	0.0	-0.4	3.6
Mean precipitation change (per cent) – autumn	387mm	507mm	-6.8	-7.1	-7.4
Mean precipitation change (per cent) – winter	301mm	320mm	-9.9	-11.3	-15.1
Extreme rainfall events	Maximum 1 day rainfall – Projected to increase 2–22 per cent				
	20-year return level of maximum 1 day rainfall – Projected to increase 5–42 per cent				
Fire regimes					
Change in number of severe fire danger days per year	0.9	0.9	1.3	Not available	2.1
Severe wind					
Maximum daily wind speed	Not available	Not available	Not available	Not available	-6 per cent to 2.5 per cent
Sea conditions					
Sea level rise (m)	0	0	0.14	Not available	0.66
Sea surface temperature (°C)	Not available	Not available	1.0	Not available	3.1
Evapotranspiration[1]			**2030 increase on baseline**	**2070 increase on baseline**	**2090 increase on baseline**
Evapotranspiration	Not available	Not available	+3 per cent	+9 per cent	Not available

	Sydney Metro – City baseline (1986-2005)	Sydney Metro – Southwest baseline (1986-2005)	2030 (RCP8.5)	2060 (RCP8.5)	2090 (RPC8.5)
Extreme Events[1]					
Hail	2050 medium emissions scenario – Average recurrence intervals of hail storm events 40mm hail or greater: Increase to 1.2 years from 1.4 years 60mm hail or greater: Increase to 5 years from 8 years 80mm hail or greater: Increase to 19 years from 28 years 100mm hail or greater: Increase to 28 years from 51 years				
Lightning	For every 1˚C of temperature increase: Lightning strikes in the USA will increase by about 12 per cent (+/– 5 per cent), resulting in about 50 per cent more strikes by 2100.				

[1] Sydney Trains 2015

Note 1: Modelling for the Intergovernmental Panel on Climate Change's Fifth Assessment Report (AR5) used Representative Concentration Pathways (RCPs) to define different projections. The RCPs are labelled according to the radiative forcing values (relative to pre-industrial levels) which could be experienced in 2100 based on different atmospheric concentrations of greenhouse gases

Note 2: Climate modelling does not typically model extreme storm projections directly – instead these events are inferred from other results.

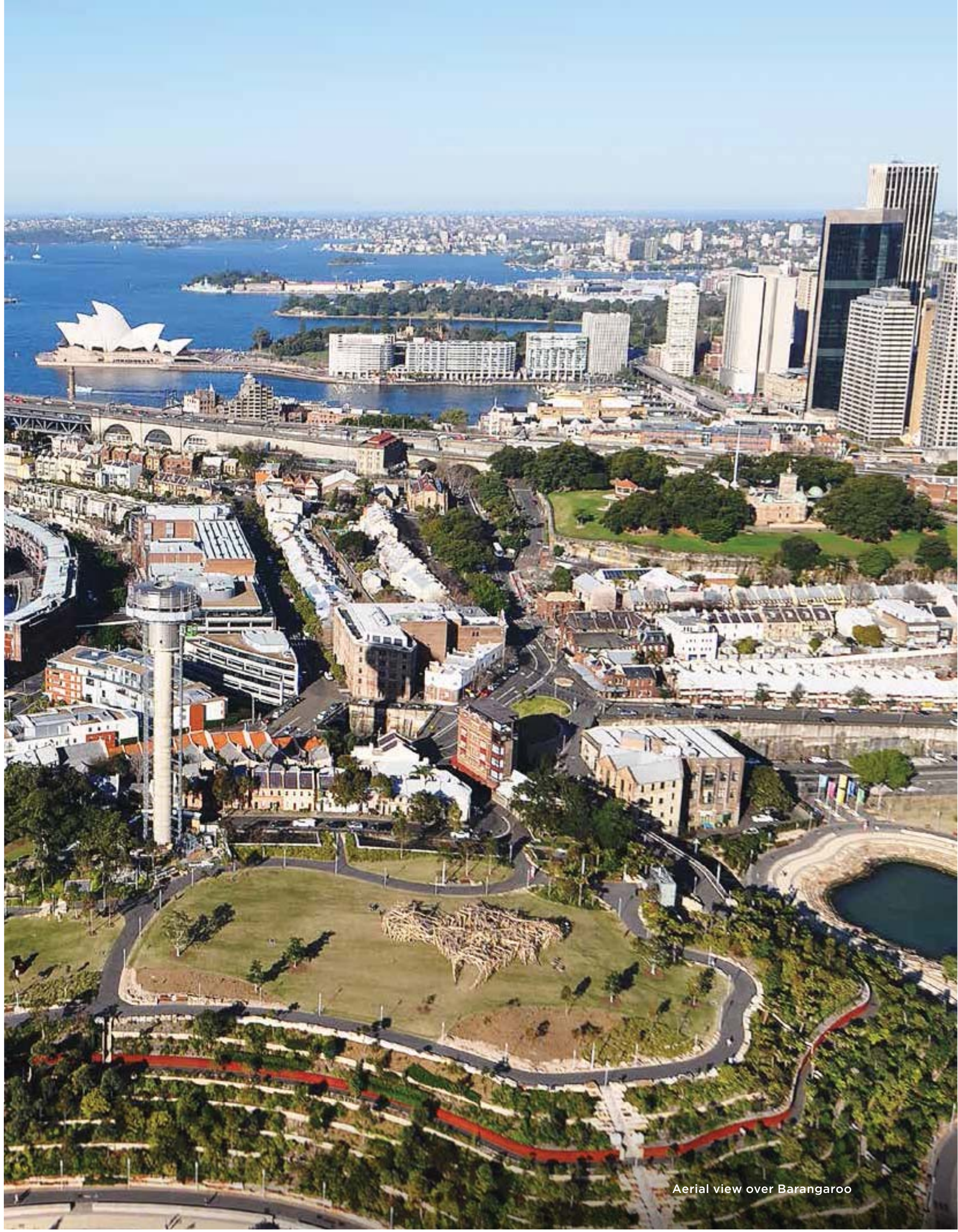
Source: Sydney Metro – City & Southwest – Technical Services Climate Resilience Report – Reference Design, Rev B, 19 August 2016 (NWRLSRP-PBA-SRT-SU-REP-000013).

Climate change risk assessment during design

Sydney Metro have used the above projections and undertaken a climate change risk assessment. The purpose of the risk assessment is to identify risks which could be addressed in the early design phase, as well as identify initiatives that can be developed in subsequent design and delivery phases of the Project and captured through contract requirements.

Overall, the results of the climate change risk assessment to date can be summarised as follows:

- No extreme, unacceptable level risks, or high, undesirable level risks identified.
- A total of 23 medium, tolerable risks identified for the Project.
- Medium level risks relate to:
  - increased rainfall, extreme events and flooding affecting station entries, interchange, precincts, station surrounds, tunnel drainage, canopies and track drainage
  - increasing daily and annual temperatures, resulting in equipment (such as tunnel ventilation and air conditioning equipment) being unable to meet the design criteria
  - sea level rise and increase in extreme events including high tides and wind waves.
  - changed rainfall patterns and groundwater levels, impacting portals, dives and embankments
  - storm events including hail storms.
- The results of the climate change risk assessment indicate that at the early design stage, the Project is largely resilient to the impacts of climate change, but highlights the need to identify adaptation opportunities during subsequent design phases.
- All risks have been integrated into the project-wide risk register.



Aerial view over Barangaroo

Key activities which have been undertaken to enhance resilience to climate change at this stage include:

- testing the sensitivity of air-conditioning systems for increased temperatures, identifying potential additional capacity that may be required within the life of the Project, and safeguarding space within the stations if required
- testing the sensitivity of ventilation systems for increased temperatures, to ensure they provide adequate capacity
- utilising flood modelling which includes an allowance to cater for predicted changes in rainfall intensity with climate change.

Climate change risk assessment during construction

At this stage, short term climate change risks identified during the construction phase of the Project relate to increased intensity and frequency of extreme rainfall events and increased temperatures, including:

- increases in the number of days where personnel are unable to work due to stop work thresholds resulting in delays in program and lost days
- an inundation of any excavations during construction
- flooding roads, congestion, and increased risk of road incidents during construction, affecting workers and/or equipment accessing sites resulting in delays in program and lost days
- increases in the number of precautionary shut down periods during extreme storm events
- increases in damage and delays to equipment
- an increasing load on temporary water treatment devices, and erosion control devices, increasing flooding events and affecting water quality treatment levels achieved
- increases in dust issues.

Increase in peak energy demand across the network and causing brownouts or power failure in temporary power supply and mains power supply.

F1.2 Future expectations

Sydney Metro will:

- Ensure key climate change resilience initiatives are included as requirements in contracts, relating to:
  - adopting conservatively high flood levels for station entries, portals, underground access points, precincts, interchanges and critical equipment and infrastructure
  - adopting a 10 per cent uplift in rainfall intensity in drainage design
  - raising station entries and fire stairs entries at Barangaroo Station to account for projected sea level rise estimates
  - designing for higher ambient temperatures for tunnel ventilation and air conditioning equipment
  - requiring sensitivity testing for climate change scenarios during detailed design stages.
- Include contractual requirements for contractors to identify climate change risks and implement climate change initiatives to ensure detailed design and construction activities are resilient to climate change, based on the latest climate change projections.
- Ensure contractors implement all necessary adaptation measures that comprehensively address risks and implement reassures to mitigate all extreme and high climate change risks medium level risks where feasible.
- Ensure contractors conduct an ongoing review of projections and update of the risk assessment and risk mitigation actions during the operations phase.
- Maintain a watching brief on future predictions including the NSW OEH's ongoing work and the Engineers Australia Australian Rainfall & Runoff review.

TARGETS:

- **Mitigate all extreme and high level risks.**
- **Mitigate a minimum of 25 per cent of medium level risks (examples include increased flooding, increased temperatures, sea level rise, and increased storm events).**

Objective	Key example initiatives
Infrastructure and operations will be resilient to the impacts of climate change	› Contractors and operators will be required to undertake updated climate risk assessments. › Identify and implement adaptation measures to mitigate extreme and high level climate change risks, and address medium level climate change risks on the Project. › Identify sites vulnerable to flooding, mitigate impacts where feasible. › Sensitivity testing of ventilation and air conditioning equipment. › Reviewing emergency procedures (severe weather plan), to address climate change impacts. › Protecting sensitive construction equipment from the effects of extreme climate and weather.

APPENDIX G
RESOURCES – WATER EFFICIENCY

OBJECTIVES:

- Minimise use of potable water.
- Maximise opportunities for reuse of rainwater, stormwater, wastewater and groundwater.
-

Potable (drinking water quality) and non-potable water will be required for the construction and operation of the Project.

G1.1 Current position

A preliminary water balance study has been completed to estimate the quantities, types and potential sources of water that will be required for the Project and identify the best opportunities to:

› Use non-potable water (where available) instead of potable water.

› Minimise the quantities of both potable and non-potable water which will be consumed.

Initial outputs of the analysis of non-potable and potable water requirements show that, across the Southwest stations, total water demand is equal to about 5,500kL per year during operation. A minimum of 60 per cent of non-potable water demand will be met by onsite rainwater harvesting and reuse, equal to a saving of approximately 3,300kL per year. Non-potable water can potentially be used at stations for flushing, cooling, irrigation and cleaning.

Based on advice provided by the technical advisers, the following design features have been included to source and use non-potable water during operations:

› Safeguarding for potential future connection of Barangaroo Station to the local recycled water network.

› Provision of rainwater harvesting and reuse systems at aboveground stations. Rainwater harvesting tanks have been included in aboveground station designs, sized to provide approximately 60 per cent of the water needed at stations.

› Connection to the recycled water system at Central Station.

Initiatives to reduce the quantity of water used include the specification of water efficiency standards for equipment, fittings and fixtures, water metering to track water use, use of landscape species which do not require significant quantities of water beyond the establishment phase, and water sensitive urban design features.

In the construction phase, the main opportunities to minimise potable water use will relate to:

› use of recycled water (e.g. water from concrete production operations) which meets water quality requirements in the concrete

› treatment and reuse of water used in some construction processes (e.g. spoil conveyors, equipment wash-down)

› specifying water efficiency requirements for equipment in temporary site facilities.

Technical analysis completed by designers has highlighted potential additional water savings opportunities associated with eliminating the need to steam-cure concrete, and connecting construction sites and tunnel segment production facilities to reliable sources of recycled water, where these are available.

Water conservation and recycling targets have been established based on technical analysis completed by designers, benchmarking, and experience on the Sydney Metro Northwest project.

G1.2 Future expectations

As the Project progresses, Sydney Metro will:

› Complete technical and feasibility analysis of connections to district systems, and the use of non-potable water in concrete.

› Embed water efficiency and water harvesting and reuse requirements in contracts.

› Include water reduction targets and recycled water targets in contracts.

TARGETS:

- **Reduce water use by at least 10 per cent compared to business as usual.**
- **Source at least 33 per cent of the water used in construction from non-potable sources.**
- **Source at least 33 per cent of the water used in operations from non-potable sources.**
- **Implement rainwater harvesting and reuse systems at construction sites and above ground stations.**
- **Source at least 60 per cent of the water used at above ground stations from harvested rainwater.**

Objective	Key example initiatives
Minimise use of potable water	› Estimate and monitor potable water usage, and implement design and construction initiatives to minimise water use. › Include water-efficient features, equipment and appliances in the design of stations and at construction sites. › Avoid use of potable water for non-potable purposes if non-potable water is available.
Maximise opportunities for reuse of rainwater, stormwater, wastewater and groundwater	› Prior to the commencement of construction undertake a water balance to inform feasibility for reuse initiatives. › Identify opportunities for treatment of water for reuse on the Project, including water from tunnelling works, concrete batching, casting facilities. › Connect to district recycled water networks where available › Use non-potable water in concrete › Harvest and reuse rainwater at permanent and temporary facilities where feasible.


Water sensitive urban design at Station

APPENDIX H
RESOURCES – MATERIALS AND WASTE

OBJECTIVES:

- Minimise waste through the project lifecycle.
- Reduce materials consumption.
- Consider embodied impacts in materials selection.
- Maximise beneficial reuse of spoil.

H1.1 Current position

The Project is aiming to minimise the environmental footprint of materials consumed through minimising the quantity of material required, selecting materials with lower embodied impacts, using recycled materials or materials sourced from environmentally accredited bodies where possible and recovering materials from waste throughout its construction and operation.

Materials

The main materials used on the Project are concrete and steel. Technical analysis has been completed by designers to identify materials and construction methods that could be applied to reduce the environmental impacts of the Project, improve durability and improve construction efficiencies. The following opportunities were identified as feasible for implementation and/or further consideration:

- reducing embodied energy and carbon through optimisation of concrete mix designs and replacing Portland cement with supplementary cementitious materials
- energy reduction and improved durability through appropriate concrete technology to eliminate the requirement for steam curing of concrete segments
- reducing impact on increasingly scarce virgin sand supplies by the reuse of tunnel spoil and the use of crushed rock fines for concrete production
- use of ultra-high performance concrete
- use of geopolymer concrete
- sourcing of steel and steel products suppliers and fabricators which are registered under certification schemes.

Initiatives which have been considered during the initial feasibility stage include:

- refining materials volumes through design
- integrating modular and prefabricated design and construction techniques
- specifying self-finished, low maintenance surfaces where practical
- reducing materiality and use of refined structural finishes
- proposing use of high performance concrete at stations, particularly for columns where minimal spatial impact is required
- developing recommended maximum Portland cement content for different concrete strengths, and recommended supplementary cementitious materials ratios in concrete for various concrete thicknesses.

Responsible materials sourcing opportunities, similar to those required for Sydney Metro Northwest have been identified in consultation with TfNSW counterparts.

Waste recycling/reuse

General solid waste and construction and demolition waste will make up the majority of the wastes generated during the delivery phase of the Project. Sydney Metro has established waste recycling/reuse targets for recyclable construction and demolition waste and construction site office waste.

Contractors will be encouraged to look into opportunities to recycle or reuse some general solid waste streams, and maximise recycling/reuse of building fit out waste.

Operational waste recycling targets have also been established based on feedback obtained on the Sydney Metro Northwest project.

Spoil reuse

Approximately 2.4 million cubic metres of spoil, comprising mainly sandstone and shale will be generated by the Project. As was the case for the Northwest project, contractors will be required to divert all clean reusable spoil from landfill, and reuse 100 per cent of usable spoil from excavated tunnels and station caverns, in accordance with the spoil management hierarchy outlined in Table H1.

Table H1 Spoil hierarchy for the Project

Preference		Reuse option
Highest	Within the Project	› Reuse in Project fill embankments and mounds within short haulage distance of source. › Restoration of any pre-existing contaminated sites within the Project boundaries. › Reuse as a feed product in construction materials (e.g. concrete).
	Environmental works	› Reuse in coastal protection works such as beach nourishment and land raising. › Reuse in flood mitigation works and other restoration works
Lowest	Other development projects	› Reuse for fill embankments and mounds on projects within an economic transport distance from site. › Reuse for land reclamation or remediation works. › Manufacturing with sand in concrete or shale in bricks/tiles.
	Land restoration	› Reuse to fill dis-used facilities, e.g. mines and quarries, to enable either future development or ecological rehabilitation.
	Landfill management	› Reuse to cap completed landfill cells. › Reuse in daily covering of landfill waste.

H1.2 Future expectations

Sydney Metro will:

- Require contractors to consider environmental impact of materials in design and procurement by undertaking life cycle impact assessments.
- Require contractors to meet the concrete and steel sourcing targets, water recycling targets and spoil reuse targets, which have been tested through design and best practice benchmarking, and market sounding.
- Continue to work with TfNSW counterparts to investigate opportunities to minimise truck movements associated with spoil transportation by exploring rail and barging options.

TARGETS:

- Reduce the environmental footprint of materials used on the project by at least 15 per cent compared to business as usual.
- Use concrete which has an average Portland cement replacement level of more than 25 per cent.
- 100 per cent beneficial reuse of usable spoil.
- Recycle or reuse 90 per cent of recyclable construction and demolition waste.
- Recycle or reuse 60 per cent of office waste during the construction phase.
- Recycle or reuse 80 per cent of the waste generated during operations.
- Recycle or reuse 65 per cent of office waste during operations.
- 60 per cent of reinforcing steel is produced using energy-reducing processes in its manufacture.
- Source 100 per cent reused, recycled or responsibly sourced timber.

Objective	Key example initiatives
Minimise waste through the project lifecycle	› Maximise recycling of construction and demolition waste by adopting waste recycling targets (90 per cent). › Enable recycling of waste materials from office facilities and customers. › Use modular, refabricated and precast structural and finishing materials to minimise waste during construction and maintenance.
Reduce materials consumption	› Design optimisation to minimise volumes of excavation, concrete and steel. › Dematerialisation of components and finishes. › Maximise reuse of existing materials, buildings, facades, and structures.
Consider embodied impacts in materials selection	› Minimise the embodied impacts of materials, including high impact materials such as steel and concrete used in the Project, through the selection of low carbon alternatives and considering durability and local sourcing.
Maximise beneficial reuse of spoil	› Beneficial reuse of 100 per cent of usable spoil from excavated tunnels and station caverns, in accordance with a spoil management hierarchy.

Some of the 100,000 concrete segments used to line the tunnels along Sydney Metro Northwest, June 2015

APPENDIX I
BIODIVERSITY CONSERVATION

OBJECTIVE:

- Protect and create biodiversity through appropriate planning, management and financial controls.

I1.1 Current position

The Project has the potential for a negative impact on biodiversity through:

› the clearing of native and non-native vegetation and habitat (including potential microbat and grey-headed flying fox habitat)

› unintended impacts on marine ecosystems in Sydney Harbour via the introduction of marine pests.

Mitigation measures have been identified through the EIS process, and will be implemented in accordance with planning approval conditions. Mitigation measures include redesigning elements of the project to avoid and minimise impacts, and the development and implementation of a biodiversity offset strategy. Biodiversity impacts are not anticipated to be significant.

The Project presents opportunities for biodiversity enhancement, such as prioritising the selection of native species when proposing landscaping options in the vicinity of stations.

I1.2 Future expectations

Sydney Metro will:

› Ensure contractors comply with mitigation measures detailed in planning approvals to minimise biodiversity impacts.

› Develop and implement a biodiversity offset strategy.

› Develop and implement a landscaping strategy to enhance biodiversity through the use of native species where possible. Targets for inclusion of native species will be established as part of the strategy.

TARGETS:

- **Minimise vegetation clearing.**
- **Native landscaping targets to be established.**

Objective	Key example initiatives
Protect and create biodiversity through appropriate planning and management	› Contract documents will contain biodiversity conservation compliance requirements. › Minimise vegetation removal. › Select native species for landscaping. › Contractors to implement clearing protocols where required. › Marine pest prevention and management completed in accordance with planning approvals.

Flowering gum tree

APPENDIX J
HERITAGE CONSERVATION

OBJECTIVE:

- Project and promote heritage through appropiate design, planning, and management controls.

J1.1 Current position

The Project has the potential to impact on Aboriginal and non-Aboriginal heritage values as a result of extensive excavation works, demolition of buildings, and modifications to stations. Heritage conservation is a key consideration throughout the design and construction of the Project and ongoing measures are being considered to ensure the historical knowledge captured can be shared with the community through various interpretation strategies.

Design development

Heritage conservation is a key objective influencing the Project's progressive design development, and the design team has considered the heritage and local value of sites when determining the alignment, station designs and other surface features.

The delivery phase

Some key heritage items identified long the Sydney Metro City route includes:

- St Leonards Centre
- MLC Building
- Blues Point
- Millers Point Conservation Area (including the Hickson Road wall)
- Martin Place Railway Station
- Bennelong stormwater channel
- properties along Pitt Street
- Central Station.

Heritage assessment work is ongoing for the portion between Sydenham and Bankstown; the assessment will consider how upgrades to stations will impact station heritage features.

During the delivery phase of the project, the project team will be focussed on ensuring those heritage items adjacent to the Project (that will not be directly impacted) are protected through construction measures and initiatives.

Where there is the potential to directly impact on items, archaeological work is planned to ensure heritage items are relocated (in agreement with appropriate bodies) or reinstated following the construction period. Archaeological Assessment Research Design (AARD) reports for non-Aboriginal heritage and Aboriginal Cultural Heritage Assessment Report's (ACHAR) for Aboriginal heritage have been developed for applicable components of the Project to ensure the archaeological aspect has been appropriately addressed. These reports will be finalised in conjunction with key stakeholders before work commences.

Interpretive initiatives

An important aspect the project team has considered in relation to heritage conservation is safeguarding the archaeological knowledge captured throughout the Project's development. A Heritage Interpretation Strategy (HIS) has been prepared for the Project and outlines a range of interpretive initiatives that considers key historic themes prominent along the Project's route, and aims to effectively communicate the history and heritage values associated with the Sydney Metro. Possible initiatives include signs and historic images in station concourses, large scale graphics and text on station platforms and passageways, design elements in interface areas, and online exhibition or digital publication.

Consultation

A cross-government Heritage Working Group has been established and comprises representatives from the Sydney Metro Delivery Office, NSW Department of Planning & Environment, Heritage Division, Sydney Trains and the City of Sydney. The purpose of the Heritage Working Group is to discuss and hold sessions on key heritage issues for the Project such as the process for consideration of heritage during the design and design responses, constraints and opportunities that have influenced station locations, ongoing design development in relation to heritage and archaeology.

J1.2 Future expectations

Sydney Metro's team of heritage architects and specialists will continue the development of a Heritage Strategy and heritage assessments for the Central and southwest stations, to inform heritage investigations, station and precinct design, and heritage interpretation plans as the Project progresses.

Interpretive material describing heritage values will be implemented and maintained. Interpretive material will convey the history, themes and stories in an engaging and interesting way so that significant previous layers of each station precinct's development are able to be appreciated.

Ongoing consultation with key heritage stakeholders and oversight by the Heritage Working Group and the Design Review Panel for the Project will be central to the success of the heritage protection and interpretation program.

TARGETS:

- **Prepare a Heritage Strategy, including stakeholder engagement with relevant stakeholders.**
- **Implement the Heritage Strategy during design and delivery, to conserve and activate.**
- **Maximise opportunities for archaeological research and future interpretation of archaeological finds.**
- **Opportunities for heritage interpretation identified and implemented at appropriate station precincts.**

Objective	Key example initiatives
Protect and promote local heritage through appropriate design, planning, and management controls	› Engage a well-resourced team of heritage specialists. › Tender documents will contain heritage conservation compliance requirements. › Identify opportunities to enhance heritage values via interpretation, and implement heritage interpretation at those locations. › Develop partnerships with relevant stakeholders to identify and utilise heritage places to promote local heritage values.

APPENDIX K
LIVEABILITY

OBJECTIVES:

- Promote improved public transport patronage by maximising connectivity and interchange capabilities.
- Provide well designed stations and precincts that are comfortable, accessible, safe and attractive.
-

K1.1 Current position

The Project will increase the rail network catchment through the provision of:

› new stations at Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street, and Waterloo as well as new underground platforms at Central Station

› more direct connections to high-capacity Sydney CBD stations at Martin Place and Pitt Street

› additional interchange capacity at Central. Martin Place, Sydenham and Bankstown, improving network connectivity and increasing demand of rail services.

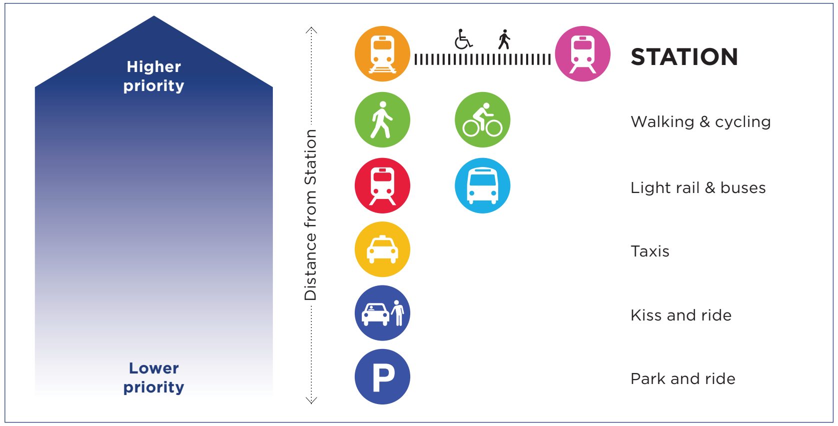
By increasing the catchment of the rail network, frequency of services, interchange with other modes and connections to key destinations, the Project is expected to increase accessibility, trip diversity and utilisation of the network during both peak and non-peak periods. This would facilitate a greater mode shift to rail from car, particularly during non-peak periods where travel service consumers will have greater choice.

The Project will facilitate a diverse range of trips, providing not only a fast journey to work but also encouraging trips for other purposes such as access within the Sydney CBD, local or business trips, access to universities and educational institutions, service and recreational uses.

Connectivity and interchange capabilities for the Project are being driven through the development and implementation of integrated multi-modal Interchange Access Plans for each station. The plans will outline principles and requirements for access and interchange at the Project's stations to help customers access the stations and improve their door-to-door journey. The plans will fold in key elements of modal access including walking and cycling, bus, taxis, kiss-and-ride, park-and-ride, and station access and interchange requirements, with reference to the following modal interchange hierarchy (refer to Figure K1).

The NSW Government Architect's Office is working to establish a 'Green Grid' of open space across Sydney and has identified the Bankstown rail corridor as providing an opportunity to connect green spaces and provide active transport linkages. As a first step, Sydney Metro is undertaking design to ensure that proposed works along the Bankstown line safeguard for future development of the active transport corridor (i.e. do not preclude its future development) and is investigating the cost and feasibility of delivering portions of the active transport corridor.

Figure K1 Modal hierarchy



Specific requirements for secure access and covered bicycle parking have been identified for each station. Work is ongoing to maximise the provision of secure access and covered bicycle parking spaces, and conduct space-proofing to safeguard for future additional parking spaces across the project.

Proposed arrangements for the retention of existing commuter car parking at the southwest stations, and provision of any additional parking are still being developed.

Sydney Metro has developed preliminary design guidelines in order to guide the design development process, and articulate expectations in terms of customer-focussed design, design quality, accessibility and safety. The development of the design guidelines has taken into consideration considered relevant local councils' urban design strategies and initiatives.

The preliminary design guidelines cover:

› the interface between stations and their surrounding locality including:
  – station entries
  – transport interchange facilities (bicycle facilities, bus stops, kiss and ride, taxi ranks and connections to existing rail, ferry and light rail transport)
  – landscaping and other public domain elements.

› rail corridor works including the tunnel dive structures, rail cuttings and embankments

› station and service buildings, including underground stations.

Design principles include:

› achieving an enjoyable customer experience
› being part of a fully integrated transport system
› being a catalyst for positive change
› being responsive to distinct contexts and communities
› delivering an enduring and sustainable legacy for Sydney.

The design guidelines include sustainable design aspirations.

K1.2 Future expectations

As the Project progresses, Sydney Metro will:

- › Develop updated design guidelines to inform the detailed design of stations, interchanges and precincts, expanding on existing guidance and addressing issues such as shade and shelter and minimising urban heat island effects.
- › Finalise Interchange Access Plans for all stations.
- › Ensure that design and delivery of the Project is conducted in accordance with the design guidelines and the Interchange Access Plans.
- › Depending on the car parking policy which is adopted, investigate opportunities to work with local stakeholders to jointly deliver space for car sharing schemes, where appropriate.
- › Investigate the implementation of the Bankstown line active transport corridor.
- › Ensure the delivery of portions of the active transport corridor as part of the Project.

TARGETS:

- **Station interchanges designed in accordance with the Interchange Access Plans and modal hierarchy.**
- **Stations and precincts designed in accordance with the Sydney Metro Design Guidelines.**
- **Maximise the provision of secure access and covered bicycle parking spaces, and safeguard for future expansion of bicycle parking.**

Objective	Key example initiatives
Promote improved public transport patronage by leveraging connectivity and interchange capabilities	› Ensure efficient transfer of customers accessing Sydney Metro from bicycle, bus, rail and passenger drop off. › Integrating the surrounding active transport network into the interchange environment and working with stakeholders to fill in missing links in the active transport network. › Provide secure access and weather protected bicycle parking spaces at station interchanges.
Provide comfortable accessible, safe and attractive stations and precincts	› Design in accordance with best practice urban design principles. › Incorporate Crime Prevention Through Environmental Design principles in design to deter crime. › Design to minimise urban heat island.

Example of a bicycle parking hub, Woy Woy

APPENDIX L
COMMUNITY BENEFIT

OBJECTIVES:

- Make a positive contribution to community health and well-being.
- Ensure community and local stakeholder engagement and involvement in the development of the project.
- Contribute to the delivery of legacy projects to benefit local communities.
- Create opportunities for local business involvement during the delivery and operations phases.
- Optimise community benefit of residual land development.
- Minimise negative impacts on the community and local businesses during construction and operation.

L1.1 Current position

The Project undertook early consultation along the Project corridor in June 2015. The aim was to collect stakeholder and community feedback on the Project with a focus on preferred station locations, tunnel versus track work and information about the rail line route.

Meetings were held with key stakeholders, including local government, New South Wales and Australian Government departments, peak bodies and industry associations.

Community and stakeholder engagement for the Project is the responsibility of the Stakeholder and Community functional group, which implements a program of consultation and other activities to:

› ensure community and local stakeholder engagement and involvement in the development of the Project

› represent the community's interests within Sydney Metro

› ensure the community is well informed of potential impacts during construction and operation.

The Project will facilitate new commercial and/or residential development opportunities above four new underground metro stations at Crows Nest, North Sydney, Martin Place and Pitt Street; at two sites which will have been utilised for construction (Chatswood and Sydenham); and on residual land at a number of locations along the existing Bankstown rail line.

There is a potential opportunity to make a provision within new developments for affordable housing and/or affordable commercial premises which would benefit the local community. Relevant policy drivers for affordable housing include, but are not limited to: A Plan for Growing Sydney; State Infrastructure Strategy (2014); City of Sydney Sustainable Sydney targets for housing (2013); SEPP Affordable Rental Housing, and the North Sydney Affordable Housing Strategy, and the Greater Sydney Commission Draft District Plans (2016).

A specialist consultant is providing advice to Sydney Metro which will inform an appropriate response to these affordability drivers.

L1.2 Future expectations

The Sydney Metro sustainability team will consult and collaborate with the Stakeholder and Community and the Workforce Development teams to scope and develop an appropriate community benefit program. Key activities will include:

› reviewing the outcomes of early community consultation

› reviewing research programs which have been implemented on other similar projects (for example, Crossrail developed community improvement plans at key locations)

› understanding community priorities and needs around each station and construction site

› determining whether any of these needs could be met or facilitated by the Project

› identifying potential sources of additional funding which may be available

› identifying opportunities for involvement of local businesses and social enterprises in the delivery of the Project

› assessing the feasibility of opportunities

› developing a strategy to minimise impacts on the homeless community which may be affected by Project works.

It is expected that contractors working in and around local communities will play their part in working with those communities to minimise impacts and build good will. Contractors will be required to implement initiatives in the local areas which benefit the local community. Example of initiatives could include fundraising, projects benefiting community groups, education, and public projects.

The affordable housing feasibility analysis will be progressed, and local community and stakeholder consultation activities will be ongoing. Feasibility investigations for the proposed Bankstown line active transport corridor will also be progressed.

TARGETS:

- **Implement initiatives which will provide tangible benefits to local community groups during the construction period.**
- **Implement initiatives which will provide tangible benefits to the broader local community beyond the construction period.**
- **Identify key drivers for affordable housing and work with other lead agencies to identify opportunities and develop an appropriate response.**

Objective	Key example initiatives
Make a positive contribution to community health and well-being	› Establish and achieve targets for identifying and completing projects which benefit local communities and make a positive contribution to community health and well-being. › Integrate station entries into public spaces and facilitate uses which benefit local communities.
Engage and involve the community and local stakeholders in the development of the project	› Seek input from the community and stakeholders throughout the planning, design and delivery stages of the Project.
Contribute to the delivery of legacy projects to benefit local communities	› Investigate and implement feasible opportunities to use residual land to benefit local communities.
Create opportunities for local business involvement during construction and operation	› Opportunities for local business involvement will be investigated.

APPENDIX M SUPPLY CHAIN

OBJECTIVE:

- Influence contractors, subcontractors and materials suppliers to adopt sustainability objectives in their works and procurement.

M1.1 Current position

A sustainable procurement strategy has been developed and implemented on Sydney Metro Northwest. The procurement strategy is based on best practice policy and frameworks including BS8903 Sustainable Procurement Best Practice Guidance and Code, and informed by benchmarking on availability and costs of sustainably-sourced materials. The strategy is designed to apply to principal contractors, their sub-contractors and their suppliers.

The strategy comprises five main elements:

› Policy
  – Objectives clearly articulated and documented with tenderers and project team
  – Strategy includes targets.
  – Sustainability knowledge building and training.

› People
  – Sustainability skill sets required in integrated teams during tender process.
  – Tenderers to demonstrate sustainability resources in organisation charts.

› Procurement process
  – Build in procedures and penalties into the contract.
  – Embed sustainability in assessment criteria and provide rationale.
  – Embed sustainability objectives into every aspect of the process from planning through the tender process to measurement of results.

› Engaging suppliers
  – Ethical sourcing.
  – Suppliers to demonstrate supply chain and diversity policies.
  – Demonstrated continual improvement of sustainability profile.

› Measurement and results
  – Encourage innovation and invite tenderers to set new benchmarks.
  – Award system to recognise excellence in sustainability.
  – Contract monitoring.
  – Independent auditing.

These same sustainable procurement principles are being applied to the Project. To improve supply chain outcomes, Sydney Metro is also:

› Aligning procurement requirements for contractors with ISCA IS Rating Tool "Pro" credits which set out performance requirements standards for demonstrating commitment to sustainable procurement, identifying suppliers, evaluation and contract award, and managing supplier performance.

› Requiring contractors to ensure high impact suppliers are provided with sustainability training.

› Ensuring contractors undertake due diligence when sourcing materials or equipment from developing countries to ensure environmental and human rights standards are not contravened in the manufacture and supply of those materials.

› Maintaining a watching brief on the development of the new ISO 20400 Standard: Sustainable Procurement – guidance.

Initiatives aimed at improving participation of local businesses and SME's in the Project supply chain are addressed in the Workforce Development and Industry Participation Strategy.

M1.2 Future expectations

Sydney Metro will:

› Require contractors to develop and implement sustainable procurement policies and strategies based on BS BS8903 and ISCA guidance, undertake supplier training and due diligence when sourcing from developing countries.

› Identify any improvements to the sustainable procurement process as a consequence of ISO 20400.

TARGET:

- **All principal contractors develop and implement sustainable procurement strategies.**

Objective	Key example initiatives
Influence contractors, subcontractors and materials suppliers to adopt these objectives in their works and procurement	› Principal contractors, develop and implement sustainable procurement strategies. › Sustainability requirements passed down to subcontractors and their suppliers. › Sustainability training provided to high impact suppliers. › Due diligence conducted to ensure supply of materials and equipment from developing countries has not contravened environmental or human rights standards.

APPENDIX N ECONOMIC

OBJECTIVES:

- Consider adopting a whole-of-life costing model to maximise sustainability benefits.
- Optimise development opportunities for residual land.
- Capture sustainability benefits in the business case for the project.

N1.1 Current position

An economic appraisal was completed for the Project to understand the economic benefits and costs of the Project. The economic appraisal considered a range of potential benefits, including benefits to:

› continuing rail customers – comprising travel time, reliability, train de-crowding, station de-crowding and amenity

› new and lost rail users – same as continuing rail users but the 'rule-of-half' was applied to benefits

› continuing bus users and road users – road decongestion due to higher rail mode share

› residual value – the remaining asset life at the end of the appraisal period

› wider economic impacts – productivity impacts from agglomeration and worker accessibility

› land use change impacts – productivity impacts and externalities from higher density land use.

The Project would provide a substantial increase in capacity for the Sydney rail network and enable the future development of a broader metro network.

Whole-of-life costs for a project include the costs of construction, operation, maintenance, renewal, disposal and replacement; plus where relevant non-construction costs (such as land), asset income (but not revenue) and externalities, such as the cost of carbon emissions.

Whole-of-life costing is being adopted:

› at a project-wide level, where the business case for the Project takes into account whole-of-life costs

› in assessing project options, where evaluations consider capital and operating costs

› in cost-benefit analysis for sustainability/energy efficiency initiatives, where the environmental cost of carbon emissions (an effective carbon price) is accounted for.

N1.2. Future expectations

As the Project progresses, Sydney Metro will:

› Continue to make decisions based on whole-of-life considerations.

› Continue to consider environmental and social costs and benefits of sustainability initiatives, where appropriate.

› Consider environmental and social costs and benefits in the detailed analysis which will be completed as part of investigating the commitment to obtain 100 per cent of operational energy from a renewable energy project, where savings in health costs associated with improved air quality will be taken into account.

Objective	Key example initiatives
Consider adopting a 'whole of life' costing model to maximise sustainability benefits.	› Include consideration of whole-of-life costs and benefits in optioneering and decision making.
Optimise development opportunities for residual land.	› Optimise over station development.
Capture sustainability benefits in the business case for the project.	› Ensure social and environmental benefits of improved access to transport and employment are documented in the business case, and ongoing benefits realisation work.

APPENDIX O
WORKFORCE DEVELOPMENT AND INDUSTRY PARTICIPATION STRATEGY – OVERVIEW

O1.1 Scope of Workforce Development and Industry Participation Strategy

Workforce development forms part of Sydney Metro social sustainability commitments and encompasses Aboriginal and Industry Participation. While workforce development has traditionally formed part of the overall sustainability strategy's objectives and targets, these are now reflected in the Sydney Metro City & Southwest Workforce Development and Industry Participation Strategy (a separate document). The strategy sets a vision, objectives and initiatives relating to workforce development to reflect industry skills requirements, local demographics, regulatory drivers and wider government priorities around skill, employment, diversity and business growth.

Sydney Metro is leading and driving the NSW Government's approach to growing skills and jobs through infrastructure investment. This will lead to increased workforce capability and capacity, mitigate skills shortages and gaps, improve productivity and provide local sustainable employment.

Benefits outlined in the Sydney Metro City & Southwest Workforce Development and Industry Participation Strategy include:

- increased availability of skills and capacity, supporting project delivery within a value for money approach
- socio-economic benefits for local communities and individuals
- development of intellectual capital through skilling, reskilling and upskilling local workers
- providing better employment options for local under-represented groups including Aboriginal people, young people and women
- increased collaboration with industry partners
- increased global competiveness of Australia's enterprises
- management of risks around providing local jobs as part of the project.

Collaboration is essential to the successful delivery of Sydney Metro workforce objectives. The Skills and Employment Advisory Group (SEAG), a strategic stakeholder forum, has been established to support the delivery of the WFD strategy, associated programs and initiatives. Members include both state and Commonwealth government, Sydney Metro and our delivery partners.

O1.2 Project and regulation drivers

The Workforce Development and Industry Participation strategy is driven by project and regulatory drivers, and associated regional and skills issues. NSW is delivering a record Infrastructure Program. The pipeline of infrastructure investment planned for the next decade provides an opportunity to grow and develop the industry as a whole and its workforce However, it will also include the simultaneous delivery of major projects competing for the same skills. This is further compounded by strong private sector investment that will place unprecedented demand on a limited supply of skilled workers.

Infrastructure skills provide dual benefits. They are a commodity in their own right, at home and in overseas markets. Infrastructure is also an enabling industry, supporting other priority sectors to maximise competitive advantage. The development of infrastructure skills capacity and capability is critical to wider Australian growth.

The Workforce Development and Industry Participation program is leading and support new and existing policy and legislation. The strategy will respond to the following government priorities and legislation:

- Infrastructure Skills Legacy Program and Demonstration pilot – The Program will support the Premier's State Priority to create jobs, together with a focussed commitment to grow skills and jobs through infrastructure investment. It aims to deliver major skills dividends from its infrastructure program by establishing minimum training and employment targets on major NSW infrastructure projects. Sydney Metro is a demonstration pilot project as part of the program.
- NSW State Priorities:
  - Increase the proportion of people completing apprenticeships and traineeships to 65 per cent by 2019.
  - 150,000 new jobs by 2019.
- Australian Jobs *Act 2013*.
- NSW Aboriginal Participation in Construction Policy (APIC).
- NSW Procurement – PBD-2016-02 Construction apprenticeships:
- NSW Procurement – Construction Skills Development Plan
- TfNSW Diversity and Inclusion Policy.

01.3 Sydney Metro's approach

Sydney Metro's priorities and objectives reflect industry skills requirements, local demographics, regulatory drivers and wider government priorities around skills, employment, diversity and business growth. These priorities and objectives have been translated into contractual requirements across all of the Project's contract packages.

Sydney Metro is also developing a number of Workforce and Industry Participation programs to respond and drive key priorities and objectives. Contractors will be encouraged to participate in programs relevant to their activities:

- Apprentice and Trainee Scheme
- Careers Program
- Skills Development Programs:
  - Sydney Metro Orientation Training
  - Sydney Metro Industry Curriculum
  - Sydney Metro Workforce Upskilling Programs
- Diversity and Inclusion Programs
- Industry Participation Program
- Job Brokerage
- NSW Infrastructure Skills Centre Facilities.

Please refer to the Sydney Metro City & Southwest Workforce Development and Industry Participation Strategy for further information.

Apprentices of the Infrastructure Skills Legacy Program, 2016

APPENDIX P

APPENDIX P1

Sustainability Strategy Highlights

CONSTRUCTION

- During tunnelling activities, the total excavated spoil (2.4 million cubic metres) could fill Darling Harbour twice, 100 per cent clean spoil will bebeneficially reused
- 90 per cent of construction and demolition waste will be recycled
- 25 per cent reduction in Portland cement in concrete, saving the equivalent carbon emissions of planting 784,000 trees
- Offsetting 25 per cent of construction electricity will reduce carbon emissions by the equivalent of planting 225,800 trees

OPERATIONS

- 100 households (20,000kL) of water usage per year will be saved through the Project's use of water efficient fixtures and rainwater harvesting
- Onsite solar panel renewable energy systems at stationswill be sufficient to power up to 200 households (1280MWh)
- Improved pedestrian and cycling connections will make walking and cycling easier, resulting in health benefits to customers
- Secure access and covered bicycle parking spaces will be provided
- 100 per cent of timber products will be from reused, recycled or responsibly managed sources
- 100 per cent of the operational electricity needs for the project will be offset (which is an estimated 221 Gigawatt hours a year). This will be the equivalent to the energy generated by 1.1 million solar panels (240 hectares solar plant) or 40 wind turbines
- Station energy performance improvements (such as lighting systems and efficient glazing) will save the equivalent electricity consumption of approximately610 households a year

Appendix P2

Stage 1 of Sydney Metro is under construction. There are thirteen stations including:

- Cudgegong Road
- Rouse Hill
- Kellyville
- Bella Vista
- Norwest
- Showground
- Castle Hill
- Cherrybrook
- Epping
- Macquarie University
- Macquarie Park
- North Ryde
- Chatswood

Stage 2 of Sydney Metro will run from Chatswood to Bankstown including the following stations:

- Chatswood
- Crows Nest
- Victoria Cross
- Barangaroo
- Martin Place
- Pitt Street
- Central
- Waterloo
- Sydenham
- Marrickville
- Dulwich Hill
- Hurlstone Park
- Canterbury
- Campsie
- Belmore
- Lakemba
- Wiley Park
- Punchbowl
- Bankstown

APPENDIX P3

Shows the contract packages which form the City & Southwest project. These include:

- Enabling works (Sydney Yard Access Bridge, Demolition contract, and other enabling works)
- Tunnels and station excavation works (TSE)
- Central Station main works (CSM)
- Sydenham Station and Junction works (SSJ)
- Southwest Station and corridor works (SSC)
- Stations, mechanical and electrical works (STME)
- Line-wide contracts (LWC) and
- Trains, systems, operations and maintenance (TSOM).

APPENDIX P4

Shows the sustainability elements of the project which have been considered, categorised as environmental, social, or economic. In the "Environmental" category, the elements listed include climate change, carbon, energy, water, waste, materials, pollution, biodiversity and supply chain. In the "Social" category, the elements listed include heritage, community benefit, liveability, supply chain, workforce development, community consultation, customer, safety and wellbeing. In the "Economic" category, the elements listed include whole-of-life costs and value for money. Figure 3 notes that workforce development, community consultation, customer, safety, wellbeing and value for money elements are addressed in other Sydney Metro documents. The remaining elements are addresses in this Sustainability Strategy.

APPENDIX P5

Outlines the sustainability framework for the project. Key inputs to the sustainability policy, objectives and targets for the project have included regulations and policy drivers, TfNSW sustainability guiding principles, lessons learned from the Sydney Metro Northwest project, and the results of best—practice benchmarking. Sustainability initiatives have been developed to support achievement of the sustainability targets and initiatives, and translated to contract requirements within each of the contract packages. Sustainability performance is managed through the development and implementation of sustainability management plans for each contract package.

APPENDIX P6

Figures 6, 7 and 8 show cross sections through a typical underground station, and illustrate opportunities for key sustainability initiatives. Key initiatives include:

- High efficiency LED lighting
- Efficient cooling
- Smart metering
- Regenerative braking and wayside energy storage
- Recycling collection
- Water sensitive urban design
- Sustainable materials
- Thermal insulation and high performance glazing
- Daylighting and natural ventilation
- Sheltered bicycle parking

APPENDIX P7

Shows the activities which were undertaken in the early stages of the City & Southwest project toward development of the sustainability strategy. Key activities include:

- Developing policy and objectives
- Developing an initial strategy and progressively updating the strategy
- Developing performance targets
- Identify, assess and integrate sustainability initiatives and programs
- Inputs to options, business case and cost plans
- Input to planning approvals
- Developing business requirements, system requirements, and contract documents, and participation in Expression of Interest (EOI), Request for Tender (RFT) and evaluation processes.

APPENDIX P8

Illustrates the Sydney Metro City & Southwest Environment & Sustainability Management System. The Figure shows the key components of the Sydney Metro system and how these are interrelated to the Contractor environmental and sustainability management system, environmental approvals and environmental protection licences. Components of the Sydney Metro system include compliance management, construction environmental management framework, sustainability targets and requirements and assurance and reporting). Components of the Contractor system include Construction Environmental Management Plans and sub-plans, environmental reports, Sustainability Management Plans and sub-plans, and sustainability reports.

APPENDIX P9

1. AVOID OR REDUCE ENERGY USE
   The first area to address when considering energy demand management is passive design. That is design that reduces the need for electricity in the first place, such as the use of natural daylight instead of artificial lighting, or humped tracks at stations to reduce the need for braking and acceleration at stations.

2. IMPROVE ENERGY EFFICIENCY
   The second area to address covers the active systems to ensure energy efficiency, such as regenerative braking technology on rolling stock and high efficiency distribution systems. Although these examples may attract higher capital costs, these can be mitigated by the long-term benefits of reduced consumption and the need for smaller sized equipment.

3. SOURCE LOW CARBON ENERGY (onsite)
   Once demand has been minimised, the next step is to consider a mechanism to enable the use of renewable generation onsite to minimise attributable greenhouse gas emissions. Examples include using of combined cooling, heating and power (CCHP) or onsite renewables (photovoltaics arrays, micro wind turbines, waste to energy etc).

4. SOURCE LOW CARBON ENERGY (offsite)
   When all steps 1–3 have been exhausted, the next option is to consider offsite renewable energy for the remaining energy demand. The proportion of renewable energy could be anywhere between six per cent (NSW Government policy minimum) to 100 per cent. The purchase of GreenPower is an easy way to do this, however other methods include solar farms, wind farms, harnessing geothermal energy through there are several implications associated with each of these options).

5. CARBON OFFSETS
   The final step in energy management is to abate any remaining energy emissions that cannot be avoided through the purchase of a recognised offset mechanism e.g. through forestry sequestration.For this Project, onsite Australian carbon credits are preferable.

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Information in this document has been prepared in good faith and is correct at the time of printing, July 2017.

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Appendix G

Temporary Transport Strategy

Temporary Transport Strategy

Sydney Metro City & Southwest Sydenham to Bankstown

Project:	Sydenham to Bankstown	**Date:**	6 September 2017
Group:	City & Southwest	**Status:**	Final
Author:	B. Watkins	**Revision:**	3.0
File name:	Sydenham to Bankstown Temporary Transport Strategy_EIS FINAL		

Version	Revision date	Status	Reason for update	Author	Reviewer	Approver	Signature
1.0	30/03/2017	Draft	First Draft	B. Watkins Sydney Metro	A. Walsh Sydney Metro	A. Walsh Sydney Metro	
2.0	10/07/2017	Draft	Second Draft	B. Watkins Sydney Metro	C. Gorman Sydney Metro		
3.0	28/08/2017	Final	Final	B. Watkins Sydney Metro	C. Gorman Sydney Metro		

Table of Contents

1. Introduction

1.1 Background

The Sydney Metro City & Southwest Sydenham to Bankstown project will upgrade all 11 stations between Sydenham and Bankstown to meet current accessibility standards before converting the T3 Bankstown Line to Metro operations. This upgrade will include a variety of construction activities that require the temporary closure of part or all of the line, during periods known as ‘possessions’.

This *Temporary Transport Strategy (TTS)* is a framework document that describes how the project will plan and deliver an integrated, multi-modal transport network that will support customer movements during temporary possessions of the Bankstown Line.

Given the conversion of the Bankstown Line will occur in stages over a number of years, each of the possessions will be slightly different. The nature of Metro construction activities will vary each possession, potentially requiring different temporary transport arrangements in response. Additionally, population growth along the Bankstown Line corridor will result in gradually increasing demand, while the delivery of improvements in the road and transport networks may create changed opportunities for travel.

Sydney Metro has investigated several options for how construction work should be scheduled and has determined that a staged program, where the majority of works are completed during school holiday periods, would minimise the overall impact on customers.

This approach will require multiple possessions over a five-year period commencing in July 2019. During each possession period up to 100,000 Bankstown Line customer journeys could be affected each weekday by closures of the line, and most customers would need to travel by other modes to reach their destination.

Transport for NSW is committed to assisting its customers during these periods through the planning and provision of alternative temporary transport services.

Acknowledging this, a *Temporary Transport Plan (TTP)* will be developed for each possession period which will include a *Services Plan* defining the temporary rail and bus services that will operate, and a *Management Plan* describing how wider impacts on the transport network will be managed during the possession. Effectively, the TTS provides guidance on what each individual TTP needs to include, and the process by which it will be developed. Each TTP will be developed to best meet customer needs and minimise adverse impacts to regular public transport services and the road network.

The success of each TTP will be measured in terms of the number of customers who choose to take public transport, walk or cycle during each possession. Each TTP will aim to be sufficiently attractive to encourage as many rail customers as possible to travel via one of these sustainable transport modes.

1.2 Objectives of the Temporary Transport Strategy

The overall objectives of the TTS are to:

- Present the proposed schedule of Bankstown Line possession periods, and temporary alternative transport arrangements that will be needed.
- Define the Bankstown Line stations that will be closed or experience changes to rail services during possessions.
- Identify the types of customers that the Bankstown Line currently serves, and the level of demand they generate.
- Identify the customer objectives to be met by each TTP.
- Define Sydney Metro's approach to planning and managing the requirements of, and impacts on each transport mode as part of developing a TTP for each possession.

1.3 Scope of the Temporary Transport Strategy

The scope of the TTS includes:

- Defining the specific objectives of each component of a TTP.
- Temporary train service plans that provide additional capacity on other rail lines where affected customers may be diverted to, and altered services on sections of the Bankstown Line that are not being converted to Metro operations.
- Integrated temporary bus services to allow customers to travel between closed stations on the Bankstown Line, and to stations on other lines. This includes understanding the opportunities that the regular bus network can provide.
- Planning specialised services for customers who may not be able to use the temporary bus services, such as those with mobility impairments or other special needs.
- Initiatives to encourage and assist customers to walk or cycle to stations on other lines, or to their destinations.
- Infrastructure to support temporary bus services including bus stops and shelters, improvements to walkways and lighting, and wayfinding and information signage.
- Improvements to the road network, such as bus priority measures to support the temporary bus services, and adjustments to traffic signals to mitigate changes in road network demand.
- Understanding the changes in parking demand near rail stations, their impacts, and measures to manage those impacts.
- Customer and stakeholder engagement strategies, including communication, information provision and supporting travel demand management initiatives.

2. Possession Schedule and Affected Customers

2.1 Possession planning and schedule

Conversion of the Bankstown Line to Metro operations will require construction activities that vary in nature, including track realignment, station works, major earthworks and bridge works. As many of these activities need to be undertaken within the rail corridor, to ensure the safety of construction workers and the travelling public, it is necessary to cease rail operations and close the line for extended periods of time.

A variety of options on how to undertake the required closures were considered by Sydney Metro. Based on the potential impacts that closures of the Bankstown Line will have on customers, it was determined to focus construction and rail possessions during school holiday periods for the following reasons:

- Lower demand on the Bankstown Line due to the number of people taking holidays during these periods and the lack of school student travel;
- Reduced traffic volumes on the road network due to the removal of school-based traffic, potentially delivering faster and more reliable journeys on replacement buses;
- Lower demand on parallel rail lines resulting in increased capacity to accommodate Bankstown Line customers who are diverted to these lines; and
- Increased bus fleet and driver availability to operate replacement services as school bus operations cease during holidays.

Only the July and December-January school holiday periods are currently proposed. April and October school holidays were also considered, but these periods are typically busier and can coincide with Easter and sporting finals, respectively.

This indicative possession program would be reviewed during detailed design in line with construction planning to ensure the available possessions are sufficient to complete the works. The schedule of possessions would be reviewed to reduce the overall impacts to the community as far as possible.

Table 1: Draft Schedule for Major Possessions

Possession	Description	Commences	Ends
1	2 Week July Possession	Sat, 6 Jul 2019	Sun, 21 Jul 2019
2	6 Week Dec/Jan Possession	Sat, 21 Dec 2019	Sun, 2 Feb 2020
3	2 Week July Possession	Sat, 4 Jul 2020	Sun, 19 Jul 2020
4	6 Week Dec/Jan Possession	Sat, 19 Dec 2020	Sun, 31 Jan 2021
5	2 Week July Possession	Sat, 3 Jul 2021	Sun, 18 Jul 2021
6	6 Week Dec/Jan Possession	Sat, 18 Dec 2021	Sun, 30 Jan 2022
7	2 Week July Possession	Sat, 9 Jul 2022	Sun, 24 Jul 2022
8	6 Week Dec/Jan Possession	Sat, 17 Dec 2022	Sun, 29 Jan 2023
9	2 Week July Possession	Sat, 8 Jul 2023	Sun, 23 Jul 2023
10	6 Week Dec/Jan Possession	Sat, 16 Dec 2023	Sun, 28 Jan 2024
11	Final Possession	To be determined	By late 2024

The development of the Management Plan for each possession would need to reflect the construction methodology and staging developed by the Contractor. Sydney Metro will work with the Contractor to encourage an approach that minimises impacts associated with possession related works.

The final rail possession for the project is expected to extend for a period of up to six months during 2024 which may include the preceding December/January school holiday period. This possession is required to allow the finalisation of works and the establishment of Metro operations including train testing, system integration and final commissioning. The duration of the final possession cannot be confirmed at this stage and will be dependent on the system operators' testing and commissioning processes.

At the time of the final possession, the first component of Sydney Metro City & Southwest – from Chatswood to Sydenham – is anticipated to have commenced operating, which would provide additional rail capacity northwards from Sydenham towards the Sydney CBD and the broader rail network.

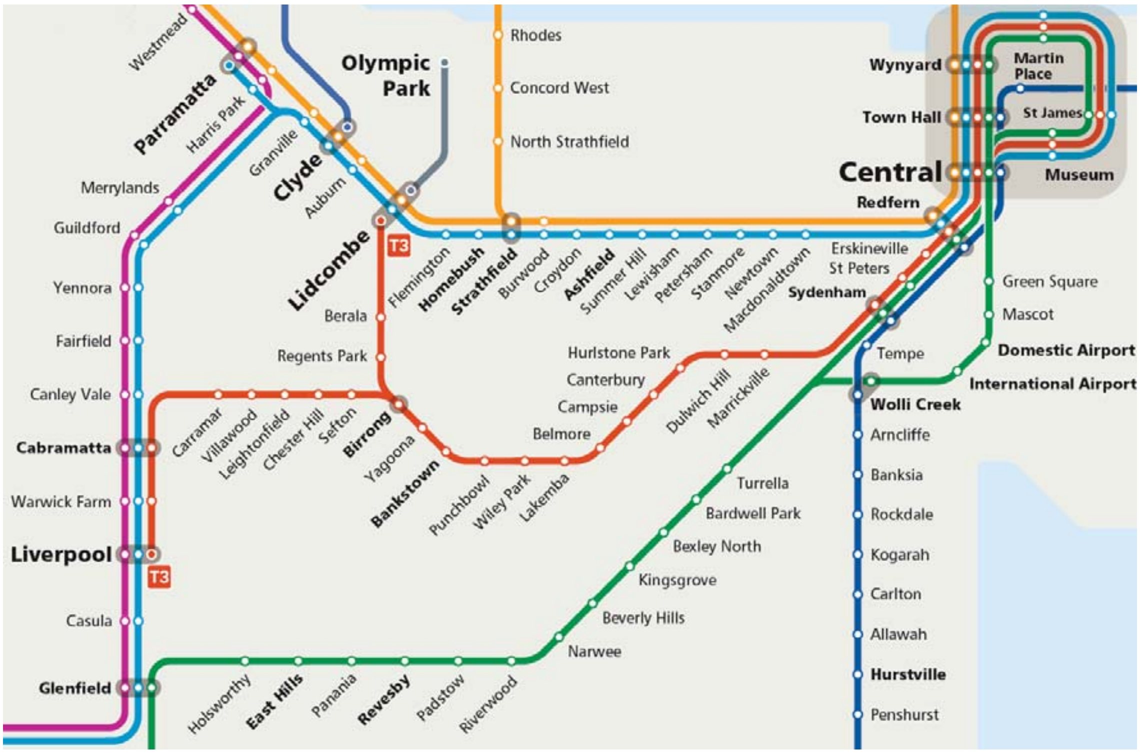
In addition to the ten multi-week possessions described in four additional weekend possessions of the Bankstown Line are planned each year, similar to those currently carried out for track maintenance.

2.2 Geographic extent

2.2.1 West of Sydenham

The Bankstown Line extends from Sydenham to Bankstown and then further west to Yagoona and Birrong before branching into two lines, north to Lidcombe and west to Liverpool via Cabramatta.

Figure 1: Plan of the T3 Bankstown Line



Source: Transport for NSW

Each of the proposed rail possessions would involve closing Marrickville Station through to Punchbowl Station, inclusive.

During the earlier possessions, the construction activity at Bankstown would not allow trains to operate from the Liverpool and Lidcombe branches into Bankstown Station. Due to how the existing tracks are configured, this will also result in the temporary suspension of train services from Yagoona and Birrong. The remaining stations between Liverpool and Lidcombe[1] would remain open during possessions but would be served by altered train services, such as a shuttle service travelling between these two terminus stations.

During later possessions after the works at Bankstown Station are completed, trains would be able to operate from Liverpool to Bankstown, and/or from Lidcombe to Bankstown.

The planning of temporary services will consider the needs of customers west of Bankstown, including those who use Yagoona and Birrong stations, who will no longer be able to travel via the Bankstown Line to destinations east of Bankstown including the CBD.

[1] Warwick Farm, Cabramatta, Carramar, Villawood, Leightonfield, Chester Hill, Sefton, Regents Park and Berala.

2.2.2 East of Marrickville

East of Marrickville, the Bankstown Line continues to the City Circle via Sydenham, St Peters and Erskineville Stations.

Sydenham Station is generally expected to remain operational during possessions and services on the T4 Illawarra Line and T8 Airport & South Line will continue to operate.

St Peters and Erskineville Stations are currently served by Bankstown Line trains, but it is possible to modify train operations so that they are served by either T8 Airport & South Line trains, or T4 Illawarra Line trains. Planning for each TTP will need to consider the best option for serving these two stations given the operating constraints in the rail network at the time.

To enable works to be undertaken at Sydenham Junction, short closures of the entire station and all lines passing through it may be required for up to five days, though this is yet to be confirmed and would be scheduled during early January when customer demand levels are at their lowest.

2.3 Identifying affected customers and demand levels

Customers that use each station along the Bankstown Line have a variety of travel demands especially when comparing the areas in the eastern part of the corridor to those further to the west. As part of the development and refinement of each TTP, a detailed assessment of customer demand will be undertaken to determine who our customers are, where they are travelling to, and when they need to travel. The Opal ticketing system provides a rich dataset for planners to gain this understanding, but this may need to be supported with information from other sources.

The following provides an example of the data that will be used to inform the development of each TTP. The data in this section is based on Opal ticketing data of customer travel from a typical weekday in August 2016.

2.3.1 Daily weekday demand

Currently, up to 54,000 customers travel on the Bankstown Line each weekday resulting in up to 90,000 customer trips. Of these, approximately 72,000 trips start or end at one of the ten stations from Marrickville to Bankstown that will be upgraded.

Over the next seven years, demand is forecast to grow by around 6% per annum. By 2019 when closures of the line commence, demand to travel on the Bankstown Line is expected to exceed 100,000 customer trips per weekday. Fortunately, demand levels during school holiday period are typically at least 15% lower than during school term.

The typical number of weekday customers recorded entering and exiting Bankstown Line stations is presented in Table 2.

Table 2: Typical daily weekday station entries and exits at Bankstown Line stations (2016)

Station	Entries	Exits
Stations west of Bankstown	**9,120**	**8,420**
Carramar	530	480
Villawood	550	480
Leightonfield	240	300
Chester Hill	1,130	1,010
Sefton	680	560
Berala	1,880	1,800
Regents Park	1,200	1,170
Birrong	1,110	1,000
Yagoona	1,800	1,620
Stations to be converted to Metro	**45,410**	**43,990**
Bankstown	8,920	9,440
Punchbowl	2,800	2,690
Wiley Park	1,880	1,730
Lakemba	3,970	3,800
Belmore	2,860	2,690
Campsie	8,150	8,100
Canterbury	2,280	2,020
Hurlstone Park	1,440	1,250
Dulwich Hill	2,610	2,370
Marrickville	4,320	4,090
Sydenham*	6,180	5,810
Stations east of Sydenham	**6,630**	**5,520**
St Peters	3,880	3,100
Erskineville	2,750	2,420
TOTAL	**61,160**	**57,930**

Source: Opal data station entries and exits, 17 August 2016 (regular school term weekday)

Notes: 1) Data for Sydenham Station includes patronage on T8 Airport & South Line and T4 Illawarra Line services.
2) Journeys that start and end at a Bankstown Line station will be recorded in both the entries and exits columns.

2.3.2 Weekday AM peak period demand

2.3.2.1 Defining the peak period

For the planning of temporary transport services, the weekday morning peak period represents the most significant challenge as this is when the highest travel demand is observed when measured on an hourly basis. This peak period is typically defined as having a 3.5 hour duration, from 6:00am to 9:30am, in which the hour with the highest observed demand is defined as the AM peak hour. The AM peak hour is also the busiest hour of the day, and represents the highest levels of customer demand that will need to be accommodated by each TTP.

The exact time that the AM peak hour occurs varies depending on location, with locations closer to the Sydney CBD experiencing it later than locations further out. For commuters travelling to the Sydney CBD, the highest demand occurs between 8:00am and 9:00am.

2.3.2.2 Station groupings

For assessment purposes, the Bankstown Line stations that will be converted to Metro between Marrickville and Bankstown are considered ‘internal’ to the corridor.

Other Bankstown Line stations are considered here as ‘external’, i.e. east of Marrickville (Sydenham, St Peters and Erskineville), and west of Bankstown (Yagoona, Birrong, Regents Park, Berala, Sefton, Chester Hill, Leightonfield, Villawood and Carramar).

Typical demand levels for the weekday AM peak period are presented in Figure 2 showing the number of customers boarding and alighting at each station on the Bankstown Line, and the station group where they travelled from or to.

2.3.2.3 Travel to and from external stations

In the eastbound direction, currently around 8,800 customers are onboard Bankstown Line trains as they approach Sydenham in the AM peak hour each weekday. 79% of these customers board at one of the ten internal stations – Bankstown to Marrickville – while the remainder board at external stations west of Bankstown.

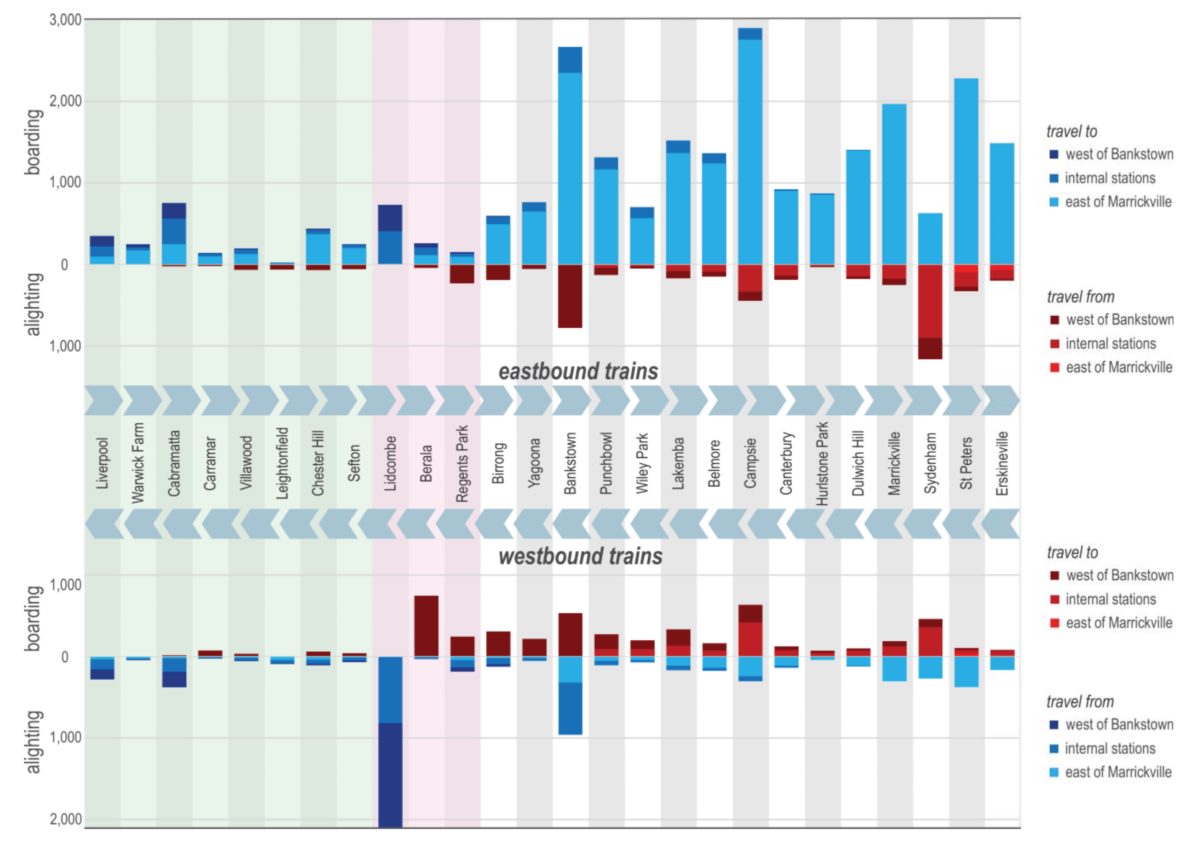
Demand in the westbound direction through Sydenham is lower, with approximately 700 customers onboard in the busiest one-hour period. 82% of these customers alight between Marrickville and Bankstown inclusive, while the remainder continue west of Bankstown. Internal Bankstown to Marrickville customers generate approximately 1,000 westbound journeys in the busiest one-hour period. Of these journeys, 62% continue west of Bankstown.

Lidcombe Station generates a large demand for westbound travel from customers transferring to the T1 Western Line and the T2 Inner West & Leppington Line.

2.3.2.4 Travel between internal stations

The internal stations also generate demand to travel between them – approximately 1,200 customers alight at one of these stations during the busiest one-hour period in the morning peak. Of these customers, 17% commence their journey west of Bankstown, 51% commence their journey from an internal station, and the remainder travel from stations east of Sydenham.

Figure 2: Typical morning peak period travel demand on the Bankstown Line (weekday 6:00am - 9:30am)



Source: Opal card data, 17 August 2016.

2.3.2.5 Observations

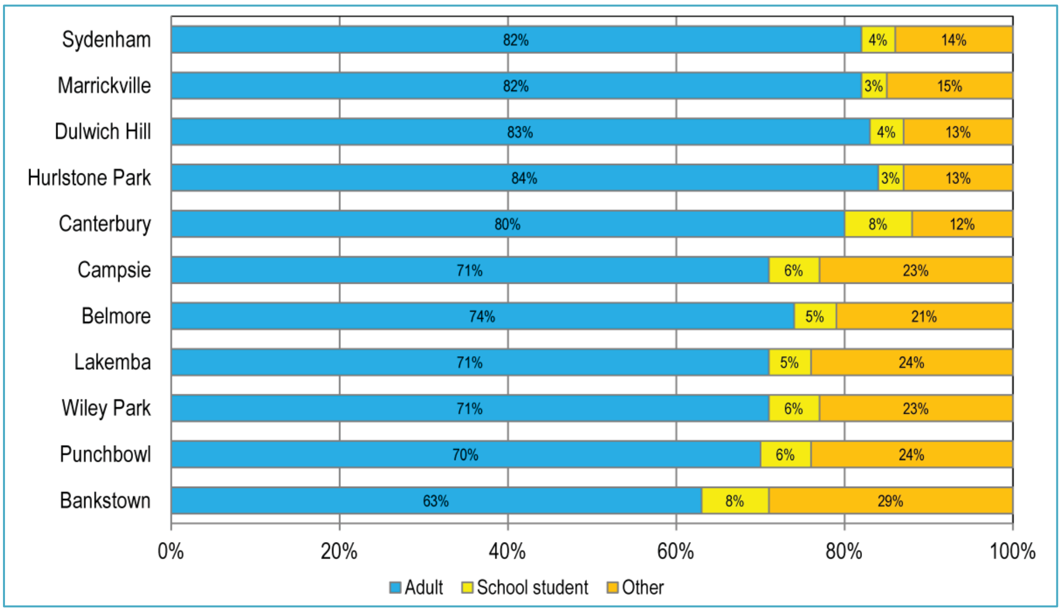
Customer travel patterns and their likely destination vary along the corridor. Figure 3 presents the destinations that customers travel to in the AM peak period, and it can be seen that in the eastern part of the Bankstown Line corridor, nearly 70% of customer travel demand is to stations in the Sydney CBD. Further west, this drops to just over 50%. The share of passengers travelling to the City stations from Sydenham is significantly lower than the other stations in the eastern part of the Bankstown Line corridor because these customers have three rail options to the City from Sydenham Station -- T4 Eastern Suburbs & Illawarra Line, T8 Airport & South Line and T3 Bankstown Line.

Figure 3: Distribution of destinations from Bankstown Line stations (typical weekday, 6:00am to 9:30am)

Source: Opal card data, 17 August 2016

Figure 4 shows the distribution of customer types at each station in the AM peak period, as recorded by Opal ticketing data. In the eastern part of the Bankstown Line corridor, over 80% of customers are classified as adults, reducing to 63% at Bankstown. The higher percentage of school students at some stations reflects that a number of schools are located close to those stations.

Figure 4: Proportion of customer types at Bankstown Line stations (typical weekday, 6:00am to 9:30am)



Source: Opal card data, 17 August 2016.

The “Other” category includes concession card holders and customers entitled to free travel.

2.3.3 Weekday PM Peak period demand

The afternoon peak period is defined as the 3.5 hour period from 3:30pm to 7:00pm although the demand to travel during this period is more evenly distributed across it when compared to the morning peak period. Consequently, the demand in the PM peak one-hour is lower than in the AM peak one-hour.

Approximately 6,000 customers are onboard a westbound Bankstown Line train departing Sydenham Station in the busiest hour each weekday afternoon. Approximately 75% of these customers alight between Bankstown and Marrickville inclusive, while the remaining 25% alight west of Bankstown.

Eastbound demand in the afternoon peak is significantly lower, with approximately 1,500 customers onboard Bankstown Line trains as they approach Sydenham in the PM peak hour.

Demand to travel between internal stations in the afternoon peak period is up to approximately 1,100 customers per hour, of which around 60% is westbound. However, this internal travel demand peak occurs around two hours earlier than the regular commuter peak hour, reflecting the use of the line for travel by school students. During school holidays periods, this student travel demand does not occur although minor increases in travel demand across the off-peak period is observed compared to school term.

3. Temporary Transport Plan Development

3.1 Temporary Transport: Services Planning and Management Planning

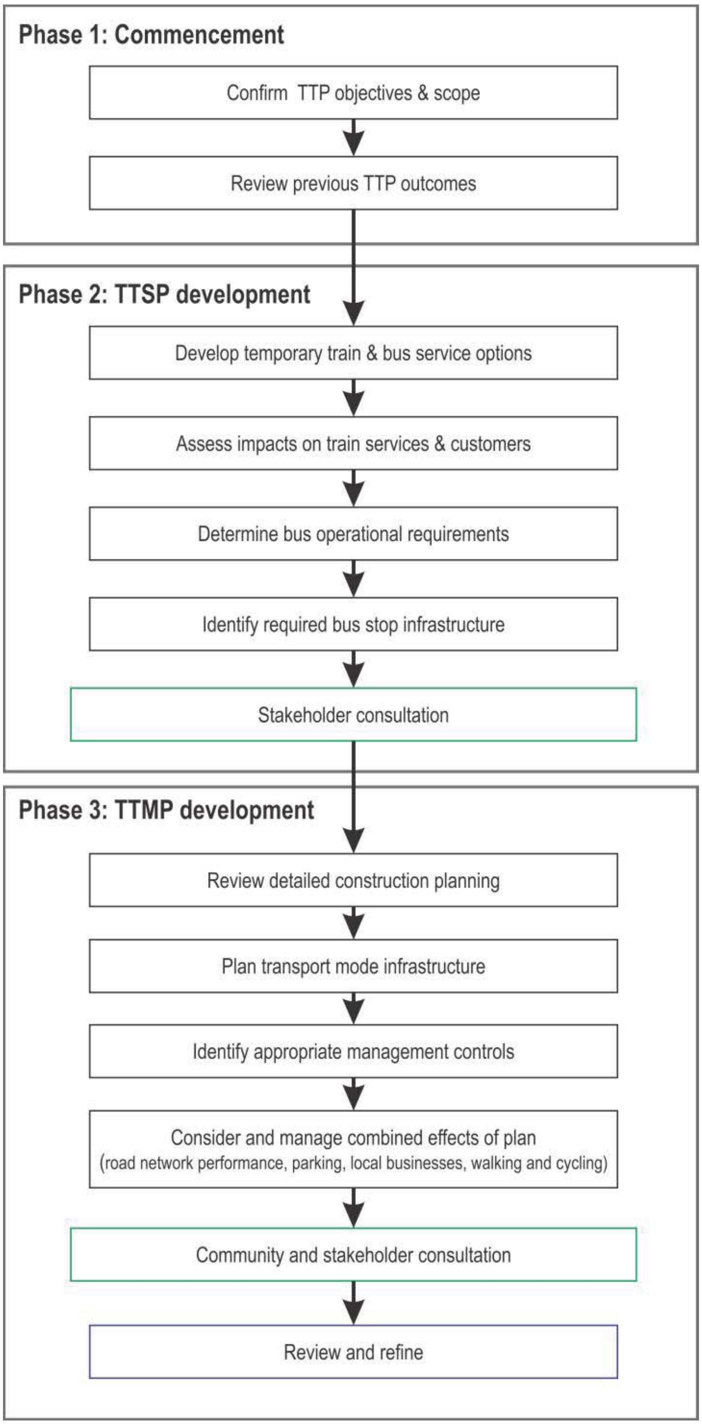
The tasks required to develop each TTP occur in a series of three phases, as shown in Figure 5.

The first phase involves confirming the objectives and scope for the TTP, and reviewing the performance of previous TTPs to determine learnings that can be applied. Development of the first TTP for the Bankstown Line will include a review of Sydney Metro's Epping to Chatswood TTP which will have concluded by that time, and subsequent Bankstown Line TTPs will learn from the ones that preceded it, in an ongoing process of revision and refinement.

The second phase involves the preparation of a *Temporary Transport Service Plan (TTSP)*, which will present the temporary rail and bus services that operate during the possession to meet the needs of affected Bankstown Line customers.

The third phase will result in the preparation of a *Temporary Transport Management Plan (TTMP)*, which will consider the wider impacts created during possessions including those of the line closure, the operation of temporary transport services and the interactions of construction activities.

Figure 5: Process for developing a TTP



3.2 Temporary Transport Plan objectives

The objectives for each of the TTPs have taken into account established Transport for NSW customer service satisfaction drivers, and the Program Objectives and Guiding Principles for Sydney Metro.

Five overarching TTP objectives have been identified and are listed below. Additionally, specific objectives have been developed for the different TTP planning tasks, and these are presented in the following chapters.

Overarching TTP Objectives
Minimise the impact for Bankstown Line customers of temporarily removing train services between Sydenham and Bankstown (or Regents Park) by delivering a comprehensive and effective temporary transport service plan
Minimise, manage or mitigate wider disruptions to other public transport services, local businesses, the community and the road network.
Be accessible by all customers.
Provide a safe environment for customers and workers by eliminating or mitigating conflicts generated by Metro construction works.
Provide a balance between minimising customer impacts and the efficient use of the resources available to deliver temporary transport services.

3.3 Temporary Transport Plan scope

Each TTP will be similar in nature, but would need to consider different construction impacts or changes in the transport network to develop the most effective multi-modal response to the closure of the line. The development of each TTP will require consideration of its scope.

As a minimum, the following would be considered in the development of each TTP.

Temporary Transport Services Plan Scope
Temporary Rail Services
Providing additional train services on the parallel rail lines to the north (T2 Inner West & Leppington Line), and the south (T8 Airport & South Line) of the Bankstown Line to accommodate anticipated increases in demand.
Providing altered train services on the sections of the Bankstown Line that are not being converted to Metro operations (west of Bankstown to Lidcombe and Liverpool, and from Sydenham east to the Sydney CBD).
Temporary Bus Services
Providing temporary bus services that travel along the Bankstown Line which offer optimised stopping patterns to serve customer needs, which may be different to existing train stopping patterns.
Providing temporary bus services between Bankstown Line stations and stations on other rail lines to provide faster travel times.

Temporary Transport Services Plan Scope
Considering potential additional stops for temporary bus services (i.e. in addition to railway stations) as a means of improving customer access to the temporary bus services.
Providing additional frequency on regular bus routes which may offer customers a more attractive alternative to the temporary bus services.
Providing specialised services for customers with impaired mobility who may not be able to use the temporary bus services.
Walking and Cycling
Identifying initiatives that encourage affected customers to cycle and walk as an alternative means of commuting, either to access temporary transport services or to travel all the way to their destination.
Temporary Transport Management Plan Scope
Supporting Infrastructure
Providing bus stops, shelters and seating for customers waiting to catch temporary bus services. Stops will be designed to be safe, accessible and well-lit. Shelters could either be temporary or permanent, depending on the location.
Identifying improvements to the station facilities on the other rail lines that Bankstown Line customers may be diverted to.
Identifying and implementing bus priority measures to improve travel times for temporary bus services.
Identifying and implementing road network improvements to mitigate increased road network demand, such as adjustments to traffic signals.
Walking and Cycling
Identifying and implementing walking and cycling connectivity and amenity improvements along the Bankstown Line to support temporary bus services.
Identifying and implementing walking and cycling improvements at stations on other rail lines to enhance customer experience connecting to alternate train services at unfamiliar locations.
Improving bicycle parking facilities at stations on other rail lines to retain existing customers and attract new customers who choose cycling to access rail stations.
Customer Engagement and Information
Working with stakeholders, including Councils and community organisations, to better understand and communicate with our different types of customers, including those with special needs or from non-English speaking backgrounds.
Developing and delivering comprehensive customer information and notifications before and during the possessions.
Providing wayfinding and information signage at affected stations and TTP bus stops to assist customers to use temporary transport services.
Supporting travel demand management initiatives, such as encouraging car-pooling for customers who choose to drive instead of using the other modes available.

Temporary Transport Services Plan Scope
Out of Scope *The following will not be considered within the scope of each TTP*
Providing temporary bus routes directly into the Sydney CBD or to destinations beyond the railway lines surrounding the Bankstown Line (excepting providing additional frequency on regular bus routes, or dedicated services required during special events). This ensures that any temporary bus routes operating beyond the closed section of the Bankstown line will be designed to take customers quickly and efficiently to a nearby point where they can access the rail network.
Constructing new parking or major new bus interchange facilities at stations on other rail lines.

3.4 TTP development, revision and refinement

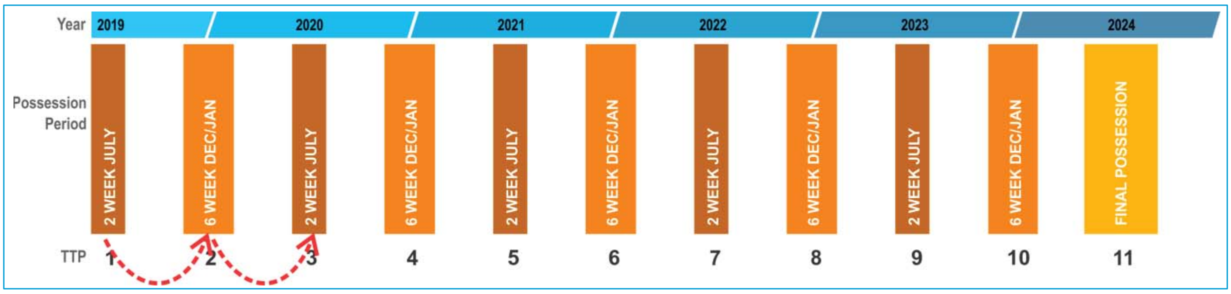
The development of each TTP involves a variety of tasks which are discussed in detail in the following chapters.

The completion of these tasks may not necessarily be sequential, and the successful development of each TTP will be an iterative process where the findings from one task may require that a previous task be revisited. This could include the need to revise the design of bus routes included in the TTSP, if the development of the TTMP finds that their operation would create unacceptable impacts.

Given that construction of the Bankstown Line will occur in stages over nearly five years, each of the possessions will be slightly different. The nature of Metro construction activities will vary from one possession to the next, potentially requiring different temporary transport arrangements in response. Additionally, population growth in the Bankstown Line corridor will result in increased demand, while the delivery of improvements in the road and transport networks may create new opportunities for travel.

A new TTP will be developed for each possession period which will define the initiatives that will be implemented prior to that possession. Following the completion of each possession period, the performance of the TTP will be assessed to determine learnings that can be used to ensure that the next TTP better meets the needs of our customers. Planning for the new TTP would retain the most effective parts of the previous plan while making adjustments necessary for any changes that might occur in the road, rail or bus networks.

Figure 6: Revision of the Temporary Transport Plan between Possessions



The revision and refinement process will apply to both the TTSP which will consider the how well temporary services performed and how well customers responded to them, and the TTMP which will review the previous impacts on and management of the road network, parking, local businesses, active transport, customer accessibility and special event management.

3.5 Baseline Temporary Transport Plan

As an input to the Sydney Metro City & Southwest Sydenham to Bankstown Environmental Impact Statement, a “Baseline” Temporary Transport Plan was developed to provide preliminary estimates of the volume of temporary bus services required to meet customer demand during a possession (refer Appendix A). The traffic and transport assessment of the Baseline TTP is provided in Chapter 10 of the *Environmental Impact Statement* and *Technical Paper* and an assessment of the noise and vibration and business impacts of the Baseline TTP is provided in Chapters 12 and 18, respectively, of the *Environmental Impact Statement*.

4. Temporary Transport Service Plan

The preparation of a Temporary Transport Service Plan requires the planning the rail, bus and specialised support transport services that will operate during possession of the Bankstown Line. This process will be guided by the following service planning objectives.

Primary Objective
Minimise the impact for Bankstown Line customers during possessions by developing an integrated network of rail and bus services that enables them to travel to their intended destinations conveniently, comfortably and safely.
Supporting Objectives
Provide adequate capacity on train services operating on other rail lines where customers could be diverted to.
Minimise disruption to existing train services and customers on other lines resulting from changes in train operations, including the sections of the Bankstown Line not being converted to Metro operations (west of Bankstown to Lidcombe and Liverpool, and east of Sydenham to the Sydney CBD).
Provide temporary bus services of adequate frequency and capacity to convey customers between Bankstown Line stations, and to stations on other lines where adequate capacity on train services is available.
Plan temporary bus routes between stations where regular bus routes already operate, providing additional service options for customers.
Plan temporary bus routes to travel along roads that are already used by regular bus routes, wherever possible.
Ensure that regular bus routes are able to accommodate customers who may choose to travel using these services instead of temporary bus services.
Ensure consistency of temporary bus routes across the day and week, so that customers only need to remember one alternate train station they need to travel to.
Provide an efficient and customer-focussed transfer experience between services and modes.
Provide specialised transport services to ensure that customers with specific mobility needs are able to travel during possessions.

4.1 Options for providing temporary additional rail capacity

For most Bankstown Line customers, travelling to their intended destination would still require them to access train services provided on other rail lines. It has been assumed that many would do so using temporary bus services delivered during each possession, while other affected customers would make their own way to the other rail lines either by car, regular bus services, cycling or walking.

Fortunately, the closure of the Bankstown Line means that the trains that would normally operate on the line may be able to be used to increase the frequency of services on other lines. For example, additional trains could be added to the T2 Inner West & Leppington Line, and/or added to the T8 Airport & South Line.

An important step in the development of each TTSP will be to determine opportunities for increasing rail capacity on parallel lines. Adding services to other lines is a complex undertaking and a number of constraints exist in terms of the capacity of lines, junctions, train fleet and stations.

This planning of temporary train services would be undertaken jointly by Transport for NSW and Sydney Trains.

4.2 Options for temporary bus services

A number of different approaches have been considered by Sydney Metro for providing temporary bus services. Each approach will form a component of the overall temporary bus service plan and provide customers with different choices on how they can travel. These components, shown schematically in Figure 7, are:

- Buses that stop at all stations along the corridor (component 1).
- Buses that only stop at a limited number of stations before continuing an express service to another station (component 2).
- Buses that move passengers to another rail line such as the T8 Airport & South Line and the T2 Inner West & Leppington Line (component 3).
- Increasing the frequency of regular bus services at specific locations, acknowledging that customers may prefer to use those instead of the temporary bus route service (component 4).

These components have been assessed in the Environmental Impact Statement, particularly impacts on traffic and transport performance, infrastructure and facilities, noise and vibration and local business operations.

4.2.1 Buses that stop at all stations along the corridor

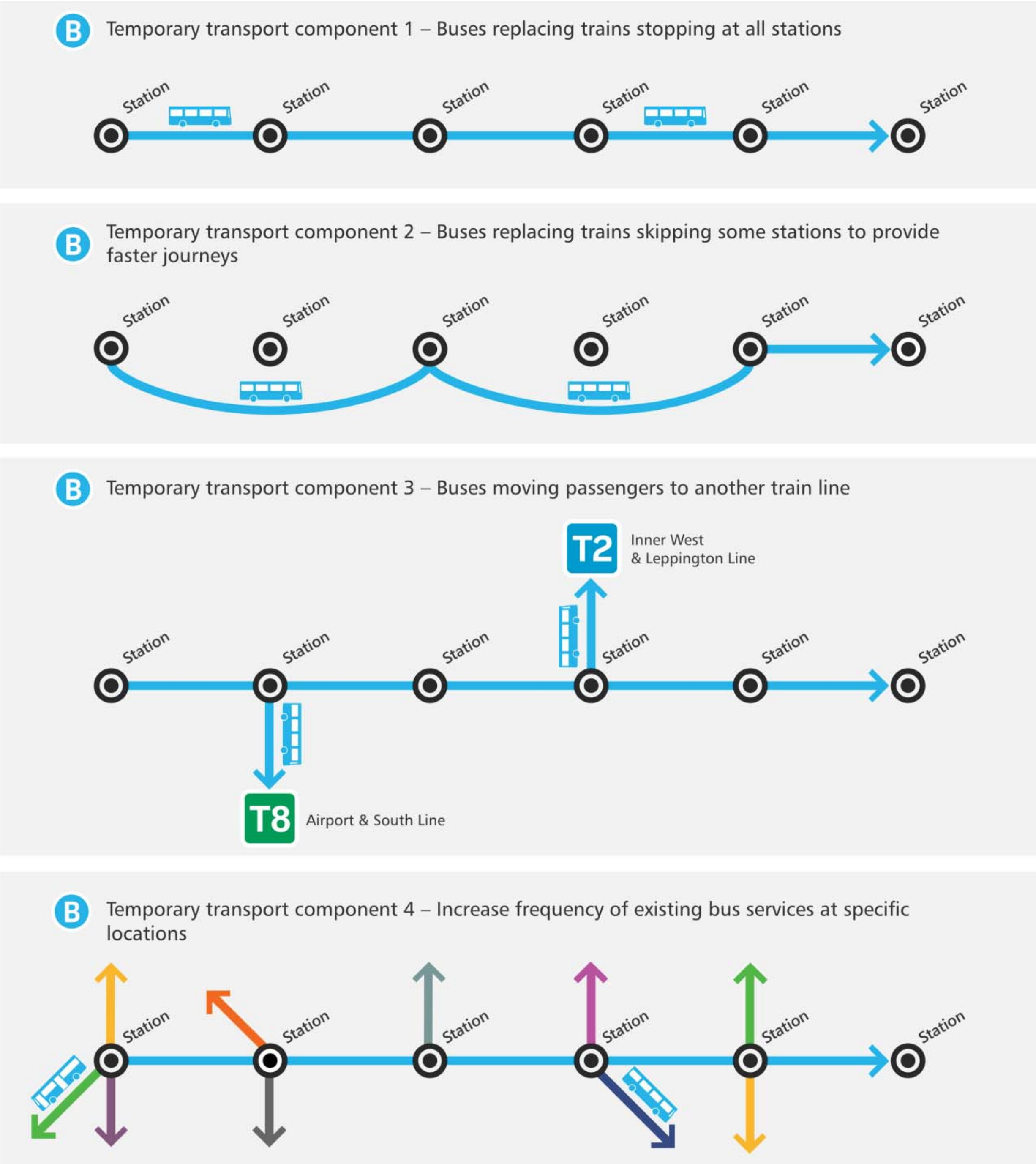
The TTSP will include an all-stations replacement bus service between Lidcombe and Sydenham. This will:

- Provide consistency between the existing train service and the temporary bus service; and
- Ensure that customers who are unaware of the temporary interruption to train services would be provided with a like-for-like replacement bus service at all times (during the hours of normal rail operation in the possession periods).

4.2.2 Buses that only stop at a limited number of stations

To provide faster journeys for customers, the TTSP may include limited stops services that skip some stations as part of their journey to or from Sydenham Station. The need for these services is influenced by the number of customers and bus loads that each station will generate at different times of the day.

Figure 7: Temporary Transport Bus Services



4.2.3 Buses that travel to stations on the T8 Airport & South Line, and T2 Inner West & Leppington Line

It is feasible that a TTSP would provide temporary bus services that travel south to stations on the T8 Airport & South Line, and/or north to stations on the T2 Inner West & Leppington Line.

Candidate stations for the transfer of Bankstown Line customers between bus and train would include:

- Revesby, Padstow, Riverwood, Narwee, Beverly Hills, Kingsgrove, Bexley North, and Bardwell Park stations on the T8 Airport & South Line; and
- Lidcombe, Strathfield, Burwood, Ashfield, Lewisham and Petersham stations on the T2 Inner West & Leppington Line.

Each of these stations can be accessed via reasonably direct routes from one or more Bankstown Line stations. The TTSP, referencing the customer markets, will determine how these stations will be included in the network of temporary bus services.

4.2.4 Increasing the frequency of regular bus services

The regular bus route network provides customers with additional options to travel. Many customers already have the choice to travel by either bus or rail, and the temporary closure of the Bankstown Line may mean they will choose to travel by a local bus route rather than a temporary bus service. Often customers will have a local bus stop closer to their home than the train station, making this option more attractive than the temporary bus service.

In the eastern part of the corridor, from Canterbury to Sydenham, several bus routes travel through the areas surrounding the stations and continue on to the CBD. These routes include the 412, 413, 423 and 428. Other routes such as the 418, 425, 444 and 491 provide connections to stations on other rail lines. The current Opal fare structure offers an inter-modal transfer discount, which allows customers to travel up to 3 km on a bus for negligible cost[2] if they transfer to or from a train, making the use of regular buses to access other train stations a potentially attractive option.

No bus routes travel directly to the CBD from west of Campsie. However, several bus services provide attractive connections to stations on other rail lines. These include:

- Routes M41 and 400 that connect Campsie to Bexley North Station and to Burwood Station;
- Routes M91 and M92 that connect Bankstown Station to Padstow Station; and
- Route M90 which connects Bankstown Station with Liverpool Station and Strathfield Station.

It is anticipated that these routes would experience increases in demand during closures of the Bankstown Line and additional services may be included to ensure overcrowding does not occur.

[2] As of June 2017, the Adult Opal fare for a bus journey up to 3 km is $2.15. A discount of $2.00 is awarded when customers using an Opal card transfer between bus and rail services, reducing the cost to $0.15 for a short bus journey taken before or after a train journey.

4.3 Review of temporary train and bus route strategies

The TTSP will review issues and risks associated with providing temporary rail and bus services under each of the identified strategies. This may include:

- Comparison of travel times between different strategies for journeys between the same origins and destinations;
- Adequate train capacity to accommodate customers transferring to or from temporary buses;
- Station accessibility:
    - lifts and/or ramp access;
    - bus access and manoeuvrability;
    - bus stop locations and capacity; and
    - connectivity between bus stops and rail platforms.
- Opportunities for bus turnaround and layover;
- Managing transition periods if the connections to surrounding train lines only operate during limited hours (e.g. peak periods only), to avoid a customer travelling to a station at a time when the connecting services do not operate, or operate at a lower frequency; and
- Managing or mitigating impacts on the performance of the road network (discussed further in Section 5.4).

4.4 Determining service frequencies for temporary train and bus services

The potential demand for temporary rail and bus services was assessed as part of the Environmental Impact Statement and will be further reviewed in the development of the TTSP. Expected customer demand during each possession will help determine the capacity and frequency of service required on both rail and bus services.

For train services, the process will determine whether the volume of demand diverted to the other rail lines can be accommodated by the capacity of train services. This includes the regular train services and any additional temporary services added during possessions.

Capital expenditure requirements (e.g. bus fleet) will also be informed by the outcomes of the demand review process i.e. the frequency of service required to meet the identified level of demand at the nominated travel times.

Key steps in the demand estimation for the TTSP include:

Step 1: Quantification of candidate trips

Candidate trips are customers who may choose to use the temporary bus and train services during the morning peak hour. These trips will be estimated from Opal patronage data and/or from forecast pre-closure rail patronage on the Bankstown Line.

Step 2: Allocation of candidate trips to temporary bus routes

Allocation of candidate trips to the most appropriate temporary bus route, based on their origins and destinations.

Step 3: Determining preliminary peak hour bus frequencies

Determination of preliminary peak hour bus frequencies required to meet customer demand for each bus route in each strategy, as an input into the model. This is done by assuming all existing rail customers are potential TTP bus customers, and providing enough buses to accommodate them all (e.g. dividing the total demand per hour for each route by 50, which is the assumed capacity of a standard bus).

Minimum frequencies could also be set at a policy level to increase customer convenience, rather than be purely demand-driven. For example, a policy decision could be made that if a temporary bus route is to operate at all, then it should operate at 10 minute headways or better.

Step 4: Determining bus route travel times

Determination of travel times for all temporary bus routes in each identified bus strategy, during weekday peak hours and other times of the day and week.

This will use a combination of existing travel time data for buses and general traffic to determine bus travel time estimates that reflect the limited stop nature of the temporary bus routes compared to the network of regular route buses, and include appropriate estimates for bus dwell times at each of the railway stations served.

Step 5: Strategic transport modelling of TTP train and bus services

Each TTSP will be modelled using Transport for NSW's *Public Transport Project Model (PTPM)*[3], specifically adapted for the Bankstown Line TTS. The PTPM will provide forecasts of customer demand:

- On each temporary bus route;
- On all operational rail lines;
- On regular bus and light rail services; and
- Demand for park and ride at rail stations.

Model inputs will include future land use projections for the Bankstown Line and Greater Sydney, anticipated changes to the regular bus route network, anticipated road network changes (e.g. WestConnex Stages 2 and 3) and proposed train service plans for the Bankstown Line possessions. The accuracy of travel times estimated in the previous step will be important, as the allocation of demand to public transport services within the model is sensitive to travel time differences between alternative options.

The modelling process will incorporate sensitivity testing which will result in a range of demand forecasts rather than a single point estimate of demand to ensure the following extremes are assessed:

- The highest possible retention of existing Bankstown Line customers as public transport users, representing the maximum possible demand for temporary bus services; and

[3] The PTPM is an incremental multi-modal strategic transport model developed by Transport for NSW, and is used on many major public transport planning projects in NSW to calculate transport user benefits to inform economic evaluations and the preparation of project business cases. This model is adapted to meet the specific requirements of individual projects, and for the Bankstown Line TTS this has included refinement of travel zones adjacent to the rail line, coding of alternate rail plans with the Bankstown Line closed, and the development of new park and ride assessment capability.

- The lowest foreseeable retention of existing Bankstown Line customers as public transport users representing the greatest diversion to car travel and the highest impact on road network performance.

Step 7: Estimation of demand outside of peak periods

Estimation of demand for the temporary bus and rail services across the remainder of the weekday (i.e. outside of the morning peak period) and on weekends will be undertaken by proportioning demand experienced at those times against peak hours.

- Opal ticketing data will be used to estimate the relative demand for early morning, off peak, evening peak, night and weekend services compared to the demand for services during the morning peak hour;
- Corresponding service frequencies across the day and across the week will be determined for each temporary bus route (e.g. if the demand at midday is 50% of the morning peak hour demand, the frequency of midday services will most likely be set at half of that during the peak hour);
- Service frequencies will be compared against target minimum service levels to determine whether or not each temporary bus service will be required to run during all time periods, or for example, only during weekday peak periods; and
- Established factors for changes in rail customer demand during school holiday periods will be applied to the demand for temporary bus routes in all time periods to determine if any adjustment in service frequency may be required, depending on the time of year in which each possession of the rail line takes place.

4.5 Assessing impacts on train services and customers on other rail lines

Each TTSP will quantify the potential increase in rail patronage on surrounding lines, and assess this against available capacity, both on the trains and at the stations themselves. The TTSP may then recommend temporary train service changes which would provide additional capacity on surrounding train lines to accommodate the anticipated increases in demand.

Due to the complexities of planning train services, the addition of temporary services will require the preparation of an alternative working timetable. This means that adjustments will be required to the timing and stopping patterns of trains that travel on the T8 Airport & South Line and T2 Inner West & Leppington Line, resulting in impacts to the regular customers of those lines.

In some cases, these impacts may be beneficial as the addition of temporary additional train services will increase the frequency of services at some stations which may in turn change the demand for train services at these stations.

Some of the changes to train services may result in changes to operations in the Sydney CBD, such as trains travelling a different direction around the City Circle.

The following will be assessed, as a minimum:

- Changes in travel times to the most common destinations (e.g. Central, Town Hall, North Sydney, Parramatta) from all rail stations at which timetable changes occur;
- Forecast changes in customer demand from all stations;
- The impact of demand changes on train loads and crowding; and

- Changes to the locations and number of passengers who need to transfer to other rail services.

If the operation of the TTSP results in substantial changes in customer behaviour and impacts on stations, such as the volume of people accessing or transferring at CBD stations, these findings will inform the TTMP and may trigger the need for specific management measures to be developed.

4.6 Determining bus operational requirements

When the numbers of temporary bus routes and frequencies are known, the bus operational requirements for implementing the TTSP will be determined. This will allow a final analysis of the cost and resource requirements for the temporary bus services.

Operational requirements will include:

- Identifying the peak number of buses required to provide the temporary bus services and enhancements to regular bus services identified in the TTSP. The bus fleet calculation will also include spare buses (to cover for maintenance requirements) and standby buses.
- Identifying the pick-up and set-down arrangements for each temporary bus route at each station served.
- Identifying the stations at which standby buses may be required, how many and where they would be positioned.
- At terminal points, identifying the requirement for and location of bus layover areas.
- Identifying how TTP buses and regular bus services will interact at locations served by both.
- Testing the capacity of bus stops to accommodate increased numbers of buses and customers, particularly where TTP buses are required to share bus stop space with buses serving existing bus routes (bus stop capacity constraints at particular locations may influence whether or not an additional intermediate stop for TTP buses is appropriate).
- Identifying the bus stop management requirements, i.e. staff to provide customer information to manage boarding and alighting, and to direct the movement of buses.
- Identifying changes to the provision or location of car parking in station areas in order to accommodate TTSP requirements.
- Identifying road network changes that may deliver improved outcomes for customers and for bus service reliability during possession periods, for example:
    - traffic signal timing changes, and
    - bus priority measures.

The analysis of these requirements including any required supporting infrastructure will be undertaken as part of the development of TTMP.

4.7 Identifying required bus stop infrastructure

To support the operation of temporary buses, supporting infrastructure works associated with the functional and operational needs of the TTSP will be identified for each station. In some cases, permanent infrastructure that provides a benefit outside of possessions may be delivered. Examples of supporting infrastructure include:

- Directional signs to/from the rail station;
- Bus route information displays;
- Temporary or permanent bus shelters that include seating and marquees for weather protection;
- Relocation of bus stop poles;
- Changes to bus zone signs; and
- Improvements to existing infrastructure required to meet DDA requirements in accordance with *Disability Discrimination Act 1992* and *Disability Standards for Accessible Public Transport 2002*.

Managing potential impacts associated with the development of this infrastructure will be undertaken as part of the development of TTMP.

4.8 Specialised transport services

4.8.1 Recognising specific customer mobility impairments and needs

Many Bankstown Line customers have an impairment that restricts their mobility, or may require assistance when using public transport. This includes:

- Mobility impaired users;
- Visual and auditory impairments;
- Cognitive impairments;
- Families with young children;
- Customers travelling with carers or assistance animals;
- Customers travelling with bulky items; and
- Customers with medical conditions.

During closures of the line, the needs of these customers will need to be met by each TTP and in some instances this may require the development of tailored solutions.

Some customers will be able to use the temporary bus services which will be designed to meet or exceed current accessibility standards. It is anticipated that all buses will be equipped with wheelchair ramps and dedicated wheelchair spaces, and bus stops will be designed to ease boarding.

However, some customers who currently travel by train will not be able to travel by bus, such as users of mobility scooters that buses are unable to accommodate. Other customers may have difficulty navigating the temporary bus stops and unfamiliar train stations that temporary bus services will travel to. For these customers, specialised transport services may be required.

4.8.2 Process for planning specialised transport services

Transport for NSW is committed to ensuring that the needs of these customers will be met during closures of the Bankstown Line through a process of:

- Gathering information on the number and types of customers who require any form of assistance when travelling;
- Engaging with community groups and disability support groups who represent customers with specific needs;
- Working with community transport providers to determine the most effective way to provide mobility for affected customers; and
- Committing to provide best practice in information provision for users with visual, hearing or learning impairments.

4.9 Option analysis

The feasibility of scenarios identified for temporary rail and bus services will be assessed against a number of considerations, including:

- Train services and customers on other train lines;
- Impacts on existing bus services;
- Impacts to road network performance and parking availability;
- Walking and cycling opportunities;
- Community and stakeholder feedback, including local businesses;
- Special event requirements; and
- Accessibility requirements for customers.

5. Temporary Transport Management Plan

The Temporary Transport Management Plan will define the processes by which the impacts created by closures of the Bankstown Line, and the operation of temporary train and bus services, will be managed.

Primary Objective
Minimise, manage or mitigate the impacts of closures of the Bankstown Line on other public transport services, local businesses, the community and the road network.
Supporting Objectives
Ensure that bus stop and train station facilities are safe, accessible and of adequate capacity.
Minimise the impacts of temporary bus service operations on the performance of the road network.
Manage or mitigate the impact of temporary bus service operations on on-street parking near rail stations.
Maximise walking and cycling as modes for customers to access stations, or to travel to their destinations.
Ensure the safety of people who walk or cycle during possessions.

5.1 Construction activities

The construction activities required to convert the Bankstown Line to Metro operations will, at times, impact the operation of temporary transport services. The TTMP will be developed in close coordination with construction planning to:

- Understand the impacts of specific construction activities, including bridge closures that will require diversion of buses and other traffic, and station construction that may impact locations intended for use as bus stops or customer access paths.
- Understand construction haulage activities and their impact on road network performance. The use of some local streets by construction vehicles may worsen traffic conditions resulting in the need to divert rail replacement bus services to avoid the roads they use.
- Ensure the safety of customers when as they walk or cycle to access train services, or to other destinations.

5.2 Public transport infrastructure and services

As described in Chapter 4, the operation of the TTSP and the implementation of supporting infrastructure have the potential to create wider impacts.

The TTMP will define how the following will be approached:

- Implementation of temporary bus stops and possible improvements to existing stops, including the planning, design, deployment and removal.
- Operational management of the bus stops including bus marshalls and customer assistance staff.

- Development and management of facilities to support bus operations, such as bus turnarounds and layovers.
- Increases in customer volumes at stations on other rail lines where Bankstown Line customers may divert to, and at CBD stations.
- Increases in customer volumes on the Inner West Light Rail where, unlike the regular bus network, providing additional service frequency may not be possible.

5.3 Specialised transport services

The operation of specialised transport services for customers with mobility requirements will need to be managed carefully to assist customers in using them. Depending on the nature of the services provided, a management framework will be needed to:

- Identify and register the customers who will need to use the services.
- Establish a booking and despatch system to enable customers to request these services.
- Plan for the operation and staffing of pick-up and set-down zones suitable for use by these services.

5.4 Road network performance

The closure of the Bankstown Line and the provision of temporary bus services will impact the performance of the road network, as assessed in the *Environmental Impact Statement*. This is due to a combination of the number of buses required to provide temporary bus services, and the decision some customers will make to drive to their destination or to drive to a different train station to access the rail network. Each TTP will address impacts to general traffic and on the operation of the temporary bus services. This will involve the analysis of key intersections and the development of options to improve their performance, such as modifying how the intersection operates, or by changing the routes that temporary bus services take between stations to avoid congested intersections.

5.5 Parking

The temporary closure of the Bankstown Line will affect the demand for parking at stations along the Bankstown Line, and at stations on the parallel rail lines where people may choose to drive to instead. The TTP will provide an estimate of the changes in demand for park and ride at all stations, allowing an identification of locations where intervention may be required to mitigate the impact of increased demand.

Parking areas along the corridor may be affected by construction activities and the need to provide temporary bus stops. This may affect both designated commuter parking spaces and general on-street parking.

Each TTP will identify what changes would be required to parking arrangements during each possession, potentially including:

- The temporary conversion of commuter car parking spaces and/or on-street parking spaces at some Bankstown Line stations to full-time bus zones to accommodate customer and operational needs of the TTP buses. This occurs at present during weekend possessions when rail replacement bus services are provided;

- Reducing the available hours of kerbside parking spaces at or near selected train stations so that the spaces can operate as a bus zone at certain times of high demand to accommodate customer and operational needs of the TTP buses;
- The provision of temporary park and ride facilities at other locations within the Bankstown Line catchment, supported by temporary bus routes to connect to rail stations on the parallel rail lines; and
- Temporary changes to on-street parking restrictions near affected stations.

5.6 Walking and cycling

5.6.1 Sydenham to Bankstown Walking and Cycling Strategy

Sydney Metro is developing a *Sydenham to Bankstown Walking and Cycling Strategy* as part of the overall planning for the project. The purpose of the Walking and Cycling Strategy is to investigate recommendations to support the increase of Sydney Metro patronage and overall walking and cycling mode share, and support the reduction in traffic congestion.

This strategy will consider improvements to walking and cycling throughout the Bankstown Line corridor, providing benefit in both the short and long term. The development of the strategy would consider:

- Existing walking conditions. Existing walking network and pedestrian demands within 800 m of each station. This task would consider the existing pedestrian mobility and accessibility requirements.

- Existing cycling conditions. Existing cycling network and bicycle rider demand within a 2.5 km catchment would consider connectivity, on and off-road safety and amenity. This task would identify network gaps and areas of conflict with other road users. Additionally, existing bike parking supply, parking type and user demands would be investigated and assessed for each station.

- Future walking assessment. Future desire lines and demands would identify preferred walking routes and identify priorities for network upgrade.

- Future cycling assessment. A cycling demand assessment would be completed to understand the future context of cycling surrounding and connecting to the Sydenham to Bankstown corridor. This work would also discuss how Sydney Metro and the proposed Active Transport Corridor, to be partially delivered by the project, could change demands and routes for future users. The demand assessment would inform the future provision of bike parking to ensure future mode share is accommodated.

- Mitigation recommendations. Initiatives identified in the strategy would assist in improving the mode share for walking and cycling to and from each station within the project.

5.6.2 Walking and cycling initiatives during possessions

Where feasible, the proposed initiatives will be delivered as early as possible so that they provide benefit during possession of the Bankstown Line and support the TTPs.

Each TTP will consider the potential impacts of the Bankstown Line closure on cyclists and on pedestrians, including:

- Identifying the extent to which pedestrians and bicycle riders may divert to stations on the parallel rail lines;
- Assessing the availability and capacity of end-of-trip facilities at stations which may attract increased numbers of bicycle riders; and
- Assessing the suitability of existing walking and cycling infrastructure to support diverted demand to/from other stations, or for customers who may choose to walk or cycle to their destination rather than use temporary bus services.

5.7 Local businesses

Closures of the Bankstown Line and the implementation of each TTSP have the potential to impact local businesses around the station precincts. This has been assessed in Chapter 18 of the Environmental Impact Statement.

The development of each TTMP will identify location specific requirements, such as the establishment of temporary bus stops near stations that consider the specific needs of adjacent businesses. If possible, options will be considered that benefit local businesses if diverted customers walking past or waiting for buses may generate positive exposure for those businesses.

5.8 Special event management

As discussed in Section 2.1, the possession schedule has been planned to avoid the April school holidays when events such as the Easter Show are held, and the October school holidays when sporting finals are often held.

However, there may still be special events that Bankstown Line customers would want to access, such as concerts held at Sydney Olympic Park or Moore Park.

The needs of each special event will be considered separately. In many cases, the standard TTSP would be able to accommodate the increased customer demand, subject to increasing bus frequencies to peak hour levels if the event occurs during the evening or on a weekend. If customer demand levels are high enough, an adapted version of the TTSP could be implemented where special services carry customers all the way to event destination.

The TTMP framework will also take a proactive approach to inform event organisers of when the Bankstown Line possessions will occur and encourage them to consider this when planning their events, eg the NRL's annual 'Back to Belmore' game.

6. Stakeholder and Customer Engagement

Objectives
Work with councils and other stakeholders to ensure the successful implementation of each TTP.
Develop effective customer communication and information strategies.

6.1 Stakeholder and community engagement

Stakeholder and community engagement has been a hallmark of Sydney Metro and will be critical in developing and delivering each TTP. Sydney Metro has used community feedback over the years to refine various aspects of the project and deliver better outcomes for people affected by construction disruption. That same approach will apply for the TTPs with our commitment to be responsive to community feedback.

Sydney Metro will work closely with community groups to understand the different needs of customers, including those with special needs, or from non-English speaking backgrounds. Sydney Metro has already begun working closely with Sydney Trains, Sydney Coordination Office, bus operators, Councils and other relevant stakeholders to ensure impacts on the community or the local transport network are properly addressed, such as the temporary reallocation of parking spaces for use as bus stops.

The approach to stakeholder and community engagement is outlined in Chapter 4 of the Sydney Metro City & Southwest Sydenham to Bankstown Environmental Impact Statement. Feedback from stakeholders and the community regarding the TTS will be invited during the exhibition of the Environmental Impact Statement and this feedback will inform development of the subsequent TTPs.

6.2 Customer information

Comprehensive customer information and communication strategies will be developed to ensure the community are aware of upcoming possessions, and the temporary rail and bus services that will be available. Information will be tailored to meet the needs of the different customer groups along the corridor, with specific materials to be developed for customers at each Bankstown Line station.

As part of the implementation of each TTP, wayfinding and information signage will be installed at each of the affected stations and TTP bus stops to assist customers to use temporary transport services provided. Sydney Metro will also investigate ways to support travel demand management initiatives to either reduce our customers' need to travel, or reduce the impact of their travel, such as encouraging car-pooling for customers who choose to drive instead of using the other modes available.

TTP 1 will be released to the community in 2018. Community and stakeholder input will be invited at that time, and will be carefully considered as we refine and finalise this first TTP, ready for implementation.

7. Summary

Conversion of the Bankstown Line to Metro operations will require temporary closures of the train line, commencing in July 2019. During these possession periods, up to 100,000 customer journeys could be affected each weekday. Sydney Metro has investigated several options for how these possessions should be scheduled and has determined that a program of multiple possessions, predominantly in school holiday periods, would yield the best outcome for customers.

The Temporary Transport Strategy (TTS) provides a framework that outlines how Sydney Metro will plan and deliver an integrated, multi-modal transport network during these possession periods. Because the possessions will occur over a period of nearly five years, the nature of each possession will be different due to progression in construction activities, and forecasted transport demand growth along the corridor. Therefore, a Temporary Transport Plan (TTP) will be developed for each possession. Each TTP will comprise a service plan (TTSP) and management plan (TTMP), that will define the initiatives to will be implemented for that possession.

The initiatives that each TTP will consider are:

- Temporary train service plans that provide additional capacity on other rail lines where affected customers may be diverted to, and altered services on sections of the Bankstown Line that are not being converted to Metro operations.
- Integrated temporary bus services to allow customers to travel between stations on the Bankstown Line, and to stations on the other lines. This includes understanding the opportunities that the regular bus network can provide.
- Planning specialised services for customers who may not be able to use the temporary bus services, such as those with mobility impairments or other special needs.
- Initiatives to encourage and assist customers to walk or cycle to stations on other lines, or to their destinations.
- Infrastructure to support temporary bus services including bus stops and shelters, improvements to walkways and lighting, and wayfinding and information signage.
- Improvements to the road network, such as bus priority measures to support the temporary bus services, and adjustments to traffic signals to mitigate changes in road network demand.
- Understanding the changes in demand for parking near rail stations, the impacts this may cause and measures to manage those impacts.
- Customer and stakeholder engagement strategies, including communication, information provision and supporting travel demand management initiatives.

APPENDIX A Baseline Temporary Transport Plan

A.1 Overview

As an input to the *Sydney Metro City & Southwest Sydenham to Bankstown Environmental Impact Statement* (EIS), a *"Baseline" Temporary Transport Plan* was developed to provide preliminary estimates of the volume of temporary bus services required to meet customer demand during a possession. These estimates were then used to assess the impact of the proposed bus services on the performance of the road network.

The Baseline TTP was developed for this purpose. It focusses solely on the planning of temporary bus services, and does not explore the other multi-modal elements described in the TTS.

A.2 Temporary bus service assumptions

Many customers are already familiar with the rail replacement buses that operate on weekends when rail lines are closed to allow for track maintenance. For the purposes of assessment, a Baseline TTP was developed that closely emulates these weekend rail replacement services. Some adjustments have been made to the weekend service plan to better serve the volume of customers travelling during weekday peak periods.

The Baseline TTP provides bus routes that travel along the Bankstown Line corridor, delivering customers with destinations in the CBD or beyond, to Sydenham Station. Subsequently, customers transfer to train services operating on the T8 Airport & South Line or T4 Illawarra Line.

This section explores how such a plan would operate and whether its performance outcomes for customers and impact on the road network would be acceptable.

A.3 Customer service objectives

Customer service objectives to inform the baseline temporary bus service requirements are:

- Ensure that all stations accessible on the existing train service between Lidcombe and Sydenham will be accessible by temporary bus services without the need to transfer between temporary bus services (i.e. a single seat journey);
- Minimise increases in travel times for the majority of customers who are travelling to/from east of Sydenham, including the CBD;
- Ensure that service frequencies in the peak hours are a minimum of 10 buses per hour. At other times, a minimum of 6 buses per hour are to be provided; and
- Provide adequate bus capacity so that passengers travelling the longest distances on temporary bus services are guaranteed a seat.

A.4 Rail service assumptions

The development of the Baseline TTP is premised on the assumption that Bankstown Station is unavailable for trains to travel to or from the west, and that the Bankstown Line stations will be closed from Marrickville through to Birrong inclusive.

The assumed rail network changes during the possession period are:

- A rail shuttle service is provided on the Bankstown Line between Liverpool and Lidcombe via Regents Park; and
- St Peters and Erskineville will be served by trains operating on the T8 Airport & South Line, or the T4 Illawarra Line.

Consequently, in the Baseline TTP Sydenham, Regents Park and Lidcombe Stations are the focal points for the transfer of customers between temporary bus routes and train services.

A.5 Temporary bus routes

As on weekends, the Baseline TTP is underpinned by an all-stops route that travels from Sydenham to Bankstown, and further to Lidcombe. This route will be part of any TTP, providing a promise to our customers of a simple, easily understood route that will enable them to travel to any of the closed stations on the Bankstown Line, at any time.

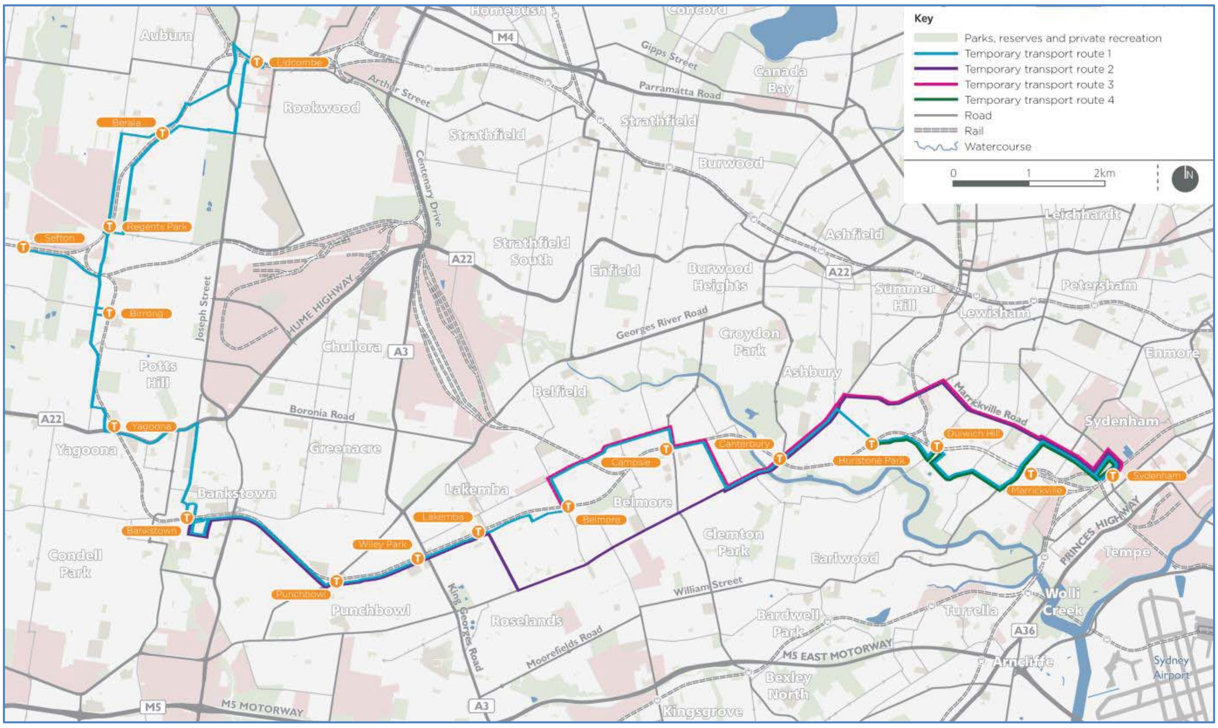
However, to meet the customer service objectives, the introduction of additional bus routes with express sections will be required to provide faster connections from the western parts of the corridor, to Sydenham. The proposed routes are described in Table A.1 and shown in Figures A.1 and A.2.

Table A.1: Temporary bus routes serving only stations between Lidcombe and Sydenham

Route	Description	Rationale
1	Lidcombe to Sydenham, all stations	• Will provide a consistent, all-hours service during each possession. • All station origin/destination combinations on the existing rail service between Lidcombe and Sydenham are also provided by the replacement bus service. • Some services will operate from Regents Park, instead of Lidcombe, to better serve customers travelling to/from the stations between Regents Park and Liverpool.
2	Bankstown to Sydenham, via Punchbowl, Wiley Park and Lakemba	• Travel times to Sydenham for customers from Bankstown, Punchbowl, Wiley Park and Lakemba are reduced compared to the all stops alternative. • The road alignment between Bankstown and Lakemba is reasonably direct and broadly parallel to the rail line. • From Lakemba Station, there is a direct route available to Sydenham via Haldon Street, Canterbury Road and Marrickville Road (i.e. not diverting via the remaining stations).
3	Belmore to Sydenham, via Campsie and Canterbury	• Travel times to Sydenham for customers from Belmore, Campsie and Canterbury are reduced compared to the all-stops alternative. • Service reliability and customer capacity are provided for customers at Belmore, Campsie and Canterbury travelling to Sydenham (buses at these locations will be more reliable than if they are required to travel all the way from Lidcombe or Bankstown; capacity constraints are reduced by limiting the number of stations served). • From Canterbury Station there is a direct route available to Sydenham via Canterbury Road and Marrickville Road (i.e. not diverting via the remaining stations).
4	Hurlstone Park to Sydenham, via Dulwich Hill and Marrickville	• Service reliability and customer capacity are provided for customers at Hurlstone Park, Dulwich Hill and Marrickville travelling to Sydenham (buses at these locations will be more reliable than if they are required to travel all the way from Lidcombe or Bankstown – important at these stations as travel times to Sydenham are relatively short; capacity constraints are reduced by limiting the number of stations served).

Figure A.1: Schematic representation of Baseline TTP bus routes

Figure A.2: Geographic representation of Baseline TTP bus route alignments



A.6 Required service frequencies

Preliminary transport modelling using PTPM4 was undertaken to inform the minimum bus service frequencies required to serve the volume of customers who travel eastbound in the AM peak hour. These are presented in Table A.2.

Table A.2: Required minimum bus temporary bus route frequencies for the AM peak hour (2023)

Route	Description	Eastbound Frequency	Westbound Frequency
1	Lidcombe to Sydenham, all stations	11 per hour	10 per hour
2	Bankstown to Sydenham, via Punchbowl, Wiley Park and Lakemba	33 per hour	10 per hour
3	Belmore to Sydenham, via Campsie and Canterbury	35 per hour	10 per hour
4	Hurlstone Park to Sydenham, via Dulwich Hill and Marrickville	22 per hour	10 per hour

Note: Additional bus volumes would be generated in the westbound direction, as buses return out-of-service to the route starting point.

A.7 Outcomes

If the Baseline TTP was implemented, it would provide a temporary transport solution that would allow customers to continue to travel to their current destinations. However, a number of issues would arise:

- A minimum of 101 buses per hour would travel through Marrickville destined for Sydenham Station in the AM peak period. This may not be feasible as this number of buses is likely to cause traffic congestion through Marrickville and Sydenham. An assessment of the impact of these buses on intersections throughout the Bankstown Line showed that delays would increase to unacceptable levels at a number of intersections. This analysis is detailed in *Sydney Metro City & Southwest Sydenham to Bankstown upgrade. Technical Paper 1 - Traffic, Transport and Access. AECOM, July 2017*.
- Having this many buses arrive at Sydenham Station in one hour would be difficult to manage given the limited space available to provide bus stops. The large number of passengers arriving on these buses could also be too great for the station to accommodate comfortably, crowding footpath areas and causing queues at the ticket gates.
- Trains arriving at Sydenham Station will have travelled via many other stations, and it is unlikely that passengers boarding would secure a seat. Potentially, the number of passengers arriving at Sydenham would exceed the available capacity on the trains travelling through the station to the CBD.
- Travel times from stations in the western half of the corridor would become unattractively long. It is expected that a trip from Bankstown Station to Sydenham Station would take at least 45 minutes in the AM peak period (compared to 21 minutes on the current limited-stops train services). Additionally, traffic conditions in peak periods often results in delays on the road network and customers would be unable to rely on the temporary bus services to get them to their destinations on time.

These issues demonstrate that a temporary bus plan designed to convey all Bankstown Line customers to Sydenham Station would be unfeasible during weekday peak periods, and that an alternative approach is required.

A.8 Next steps for developing temporary bus service strategies

To mitigate the identified impacts and to provide a better customer outcome, it will be necessary to convey some customers by temporary bus services to stations on other rail lines instead of Sydenham Station.

The Customer Service Objectives will guide the development of each TTP, which will be undertaken to achieve a workable balance between the following key requirements:

- Minimising customer travel times including the reduction of customer waiting and transfer times;
- Conveying customers to rail stations where adequate capacity is available (or can be added) to prevent overloading of train services;
- Distributing temporary bus services so that they travel to several rail stations to reduce the impact on any one station; and
- Achieving consistency between services provided in peak periods and those at other times, where possible.

For customers travelling towards the CBD from west of Campsie, their total journey time would be reduced if a temporary bus service took them to a station on the T8 Airport & South Line. For example, a bus journey from Bankstown Station to Padstow Station would be as short as ten minutes and experience less of the traffic congestion that exists further east. If customers were to board a train at Padstow that had commenced its journey one station to the west, at Revesby, they would be likely to get a seat for their entire journey to the CBD.

Taking this approach for each of the stations from Belmore through to Bankstown could reduce the number of buses that need to travel to Sydenham, creating a more manageable outcome. It would also cost less to operate, require fewer buses, and reduce the impact of these buses on the road network.

A preliminary approach to refining the temporary bus plan, as presented in Figure A.3, would reduce the number of buses that travel to Sydenham Station by 45%, compared to the Baseline TTP.

It may also be possible to convey customers from Campsie and Canterbury Stations to other train lines, which would not necessarily provide a faster journey than travelling via Sydenham, but would act to further reduce the number of buses travelling through Marrickville and Sydenham.

Figure A.3: Refined temporary bus plan approach to reduce bus volumes to Sydenham