3 Sydney Metro West development and alternatives

3 Sydney Metro West development and alternatives

This chapter describes the evaluation process undertaken to determine the preferred option for the Sydney Metro West Concept. It includes an overview of the strategic alternatives, alignment options, station options, and technical design and construction options.

3.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to alternatives and options and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 3-1.

Table 3-1: Secretary's Environmental Assessment Requirements – Alternatives and options

Reference	Secretary's Environmental Assessment Requirements	Where addressed
2. Environmental Impact Statement		
2.1	The EIS must include but not necessarily be limited to, the following: g. a statement of the strategic objective(s), including: • how the Concept will integrate with the broader transport network (existing and proposed); • an analysis of any feasible alternatives; • a description of feasible options within the Concept (including station numbers and locations); and • a description of how alternatives to and options within the Concept were analysed and optimised to inform the selection of the preferred alternative/option. The description must contain sufficient detail to enable an understanding of why the preferred alternative to and options(s) within the Concept were selected;	The strategic objectives and how the Concept would integrate with the broader transport network is addressed in Chapter 2 (Strategic need and justification). The remainder is addressed in sections 3.3 to 3.8.

3.2 Overview of the Sydney Metro West development process

The Sydney Metro West development process has been driven by the identified strategic need to improve connectivity between Greater Parramatta and the Sydney CBD, and has included:

- Consideration of alignment options and the type of service, including determining the optimal balance of travel time between the Parramatta and Sydney CBDs and the number of stations to enable people to access metro services
- Analysis of options for station locations
- Analysis of options for a stabling and maintenance facility
- Analysis of options for the approach to tunnelling.

Development has been carried out in consultation with stakeholders and the community. This is further detailed in Chapter 5 (Stakeholder and community engagement).

3.3 Strategic alternatives

As part of the development process for Sydney Metro West, a range of potential strategic alternatives to Sydney Metro West have been considered. These alternatives are presented below and are based on the future transport infrastructure network documented in Future Transport Strategy 2056 (Transport for NSW, 2018). Future Transport Strategy 2056 identifies a range of committed transport initiatives, as well as future transport investment initiatives that will be subject to further investigation in the short, medium and long term.

The strategic alternatives relevant to Sydney Metro West and the Parramatta CBD to Sydney CBD corridor include:

- Do nothing
- Improvements that can be achieved through implementing regulatory, governance and better-use reforms
- Improvements to other parts of the transport network, including road, bus, light rail and ferry
- Improvements to other parts of the Sydney Trains network.

3.31 Do nothing

Demand on much of Sydney's rail network is nearing capacity during the morning and evening peak periods. To ensure continued growth in productivity, cater for forecast employment and population growth, and sustain the city's liveability, Sydney's transport capacity will need to substantially increase.

If the additional mass transit capacity offered by Sydney Metro West does not proceed, it is expected that:

- The T1 Western Line, T9 Northern Line and T2 Inner West and Leppington Line will continue to operate at or near capacity at peak times, with very limited capacity for new growth in the corridor
- The road network in the corridor will continue to operate at capacity in peak times, creating congested roads and increased travel times for motorists and bus customers
- The lack of transport connectivity at key precincts such as Sydney Olympic Park and The Bays will not be adequately addressed
- The long term public transport capacity requirements for the projected population and employment growth between Parramatta and Sydney CBD would not be met
- Growth would more likely be accommodated on Sydney's urban fringe in areas with more limited access to public transport, which would contribute to ongoing urban sprawl and congestion. Alternatively, growth may occur in an unplanned manner within existing communities, potentially impacting local character and amenity
- There would be reduced potential for development of areas and new housing stock
- There would be reduced productivity and international competitiveness due to congestion and reduced clustering of businesses in economic centres within the Greater Parramatta to Sydney CBD corridor.

3.32 Regulatory, governance and better-use reforms

The NSW Government has considered a range of regulatory, governance and better-use reforms to improve transport and land use outcomes, to cater to growing transport demand and meet Sydney's growing population needs. These reforms include continued implementation of rail network improvements such as automated signalling and increased frequency of rail services as part of the More Trains, More Services program, more efficient use of roads, more frequent bus and ferry service and bus priority initiatives. Reviews of transport legislation to allow for more flexible services and integrated transport and land use planning have also been investigated.

Other commitments set out in Future Transport Strategy 2056 include:

- Public transport passenger service improvements
- Investment in digital technology, such as the Intelligent Congestion Management Program
- Investments to ease congestion by optimising the network and better use existing infrastructure, such as via the Bus Priority Infrastructure Program, the Pinch Point Program, smart motorways and clearways
- Transport access program to improve access to train stations and ferry wharves.

While these reforms are vital to meeting the NSW Government's policy objectives and are already being implemented, additional investment in transport infrastructure is needed so that Sydney's transport network meets future demand.

3.33 Transport mode alternatives

Further investment in road, bus and light rail as a strategic alternative to Sydney Metro West has been considered including new motorways, suburban rail connections, bus rapid transit services, and increased ferry services.

Buses and light rail are complementary to mass transit modes, bringing customers to and dispersing them from the major transport hubs served by the Sydney Trains suburban rail network and metro rail services. Buses can also potentially provide a flexible response to local demand pressures and light rail can offer medium capacity solutions for major transport corridors, replacing lower capacity bus services. However, these modes would not provide sufficient mass transit capacity to address Sydney's transport bottlenecks in the Greater Parramatta to Sydney CBD corridor.

Ferry services tend to be slower and less reliable than rail services. Ferry travel times between Parramatta and the Sydney CBD are also impacted by speed restrictions on the Parramatta River, and natural low tides between Rydalmere and Parramatta reduces service reliability.

The NSW Government is currently investing in projects to improve transport and land use outcomes in the Greater Parramatta to Sydney CBD corridor. These include the future Parramatta Light Rail (Stage 1) and planned Parramatta Light Rail (Stage 2), the Parramatta Road Corridor Urban Transformation Strategy and road projects such as WestConnex.

The current and planned light rail network would largely serve local demand focused on the Parramatta and Sydney CBDs and provide feeder services to mass transit spines (currently the Sydney Trains network), rather than providing connectivity across the entire corridor.

While current committed and future initiatives are important to service key precincts within the corridor, these projects on their own cannot wholly support the large hourly commuter movements required in and out of the Parramatta and Sydney CBDs which requires a mass transit system such as that provided by metro rail.

3.34 Rail network alternatives

The NSW Government is currently investing in improvements to the Sydney Trains suburban rail network, through the More Trains, More Services Program which includes extra rail services, new trains on the suburban network and upgraded rail infrastructure.

As part of the program, in late 2017, an extra four express services were provided between Parramatta and Sydney CBD in both the morning and afternoon peaks, increasing the service to 20 trains per hour.

While the More Trains, More Services Program is important to accommodate customer growth and continually increase demand across the existing Sydney Trains suburban rail network, an additional solution is required to meet demand for rail services between the Parramatta and Sydney CBDs in the long term. So that joint objectives are achieved, the More Trains, More Services program would need to be integrated with Sydney Metro West.

Additionally, these improvements to the existing Sydney Trains suburban rail network are unable to support opportunities related to housing growth and the development of new areas. Without the provision of new stations, these improvements will not provide services to new rail catchments and key precincts currently not serviced by rail, including The Bays and direct services to Sydney Olympic Park.

Other longer-term future transport initiatives identified for investigation in Future Transport Strategy 2056 include:

- Parramatta to Bankstown to Hurstville/Kogarah Mass Transit/Train Link
- Parramatta to Epping Mass Transit/Train Link
- Parramatta to Norwest Mass Transit/Train Link
- Macquarie Park to Hurstville Mass Transit/Train Link.

These future transport initiatives do not fundamentally service the Greater Parramatta to Sydney CBD corridor, and in many instances would be complementary to Sydney Metro West.

3.4 Travel time between Parramatta and the Sydney CBD

A guiding principle for Sydney Metro West is to offer a faster trip than would be possible on the existing T1 Western Line between Parramatta and the Sydney CBD. The fastest travel time between Parramatta and Wynyard Station on the existing Sydney Trains suburban rail network is 31 to 33 minutes. Travel time between the two cities is important to support both the '30-minute city' concept and to facilitate improved customer, transport and land use outcomes.

This principle has influenced further development of Sydney Metro West, including alignment and station options. Key considerations in determining an optimum travel time between Parramatta and the Sydney CBD are detailed below.

3.4.1 Importance of travel time

The Greater Sydney Region Plan: A Metropolis of Three Cities (Greater Sydney Commission, 2018a) provides direction to develop more accessible and walkable 30-minute cities. This means more people should have 30-minute public transport access to one of the three cities and to services in their nearest strategic centre seven days a week. Through integrated land use and transport planning, Sydney Metro West would support this vision and link houses, jobs, education, health and other services.

Customers travel for a range of reasons, including commuting, business-to-business and leisure trips. Meeting the travel time needs for all trip purposes is a key consideration for travel time between the two cities.

3.4.2 Influences on travel time

A range of factors influence travel time, including the number and location of stations, train type and station design. The challenge of balancing the optimal number and location of stations with travel times has a direct influence over the land use outcomes, economic benefits, expanded customer catchments and increased network connectivity.

The speed of the rolling stock and efficiency of the station and platform design also influence travel times. The speed of the rolling stock would provide a comfortable journey for customers as well as offering a good balance between comfort and travel time between the two cities. The number of doors and internal configuration of the rolling stock would be designed to provide customers with efficient boarding and alighting times, with train dwell times of around 30 seconds at each station.

3.4.3 Optimum travel time between the two cities

The optimum travel time between Parramatta and the Sydney CBD is about 20 minutes. A travel time of about 20 minutes delivers a range of combined benefits for customers within the Sydney Metro West corridor, as well as for Greater Sydney, including:

- Greatest balance of benefits for customers travelling for a range of reasons, including commuting, business-to-business and leisure trips
- Offers greater economic benefit through a balance of fast travel times, new stations within the corridor to create new rail catchments and improved transport connectivity
- Supports the '30-minute city' concept by offering customers a high-frequency, turn-up-and-go service
- Allows intermediate stations to be delivered along the alignment, to open up new rail catchments and expand connections across the transport network
- Expands the 30-minute catchment for the key anchor precincts of Sydney Metro West at Sydney Olympic Park, The Bays and Greater Parramatta
- Provides the highest volume of travel time benefits to the largest number of customers across Greater Sydney, when compared to a 15- or 25-minute trip.

3.5 Alignment alternatives

3.5.1 Strategic alignment and service alternatives

Four strategic alignment and service alternatives have been evaluated by Sydney Metro. A key consideration in decision making around alignment options was the balance between travel times and number of stations. Options investigated were:

- About four to five stations from Parramatta CBD to the Sydney CBD (inclusive) ('Metro Express'). This option would achieve a higher speed but service a small amount of stations. This option was found to be limited in its ability to service a large catchment due to a minimal number of stations
- About nine to 10 stations from Parramatta to the Sydney CBD (inclusive) ('Metro Rapid'), with anchor precincts at Parramatta, Sydney Olympic Park, The Bays and Sydney CBD. This option was found to achieve a balance between an efficient travel time between Greater Parramatta and Sydney CBD, and the ability to service a large catchment area and key precincts
- About 11 to 12 stations from Greater Parramatta to the Sydney CBD (inclusive) ('Metro Local South'). This option would service a large catchment due to a higher number of stations, yet result in a higher travel time between Greater Parramatta and the Sydney CBD. An 11 to 12 station option north of Parramatta River ('Metro Local North') was also investigated; however this alignment would be unable to service key precincts including Sydney Olympic Park.

This evaluation concluded that a service with about nine to 10 stations was the preferred option as it could achieve a balance between travel times and an optimal number of stations to service a large catchment. This preference was the basis for further development of the Concept, which involved considering station location options as well as other criteria, such as horizontal curves and vertical grades, geology, and the need to avoid underground structures such as major utilities and basements. Options investigated for station locations are detailed in Section 3.6.

3.6 Station location options

The evaluation of station location options to date has followed a three-phase process:

- Strategic station locations: Identified the key locations to be serviced at Parramatta, Sydney Olympic Park, The Bays and Sydney CBD
- Preliminary station locations: Identified that adding Westmead as a core station provided significant benefits
- Assessed and shortlisted station option pairs for Westmead and Parramatta and to connect to the T1 Western Line
- Assessed station location options between Parramatta and Sydney Olympic Park
- Assessed and shortlisted station options to connect to the T9 Northern Line
- Assessed and shortlisted station options between the T9 Northern Line and The Bays
- Shortlisted station locations: Involved detailed analysis of the short-listed station locations.

Further investigation is currently underway to identify an optimum station location within the Sydney CBD. An additional phase is also underway (strategic station options) to investigate the feasibility and affordability of stations at Rydalmere and Pyrmont. These strategic station options at Rydalmere and Pyrmont are currently being investigated and do not form part of the Concept at this stage.

Options to be investigated for metro stations were identified through:

- Engagement with community and stakeholders including local councils and industry
- A strategic station location process conducted by Sydney Metro
- Consultation with key government stakeholders including the Department of Planning, Industry and Environment, the Greater Sydney Commission, other sections of Transport for NSW and the Department of Premier and Cabinet.

Activities undertaken to support the station location options evaluation included:

- Feedback from community and industry engagement
- Land use and transport modelling
- Scoping design, technical feasibility and engineering studies
- Feedback from key stakeholder workshops and working groups.

3.6.1 Strategic station locations

Preliminary investigations identified that stations at Parramatta, Sydney Olympic Park, The Bays and Sydney CBD would provide connections to key centres along the corridor and were core to the Concept (referred to as 'core stations').

These station locations were announced in November 2016. An interchange with the T1 Western Line was also determined to be a key element of the Concept to provide relief to this service, which was expected to become overcrowded without intervention. The benefits and reasoning for each of the core stations is provided in Table 3-2.

Table 3-2: Core station evaluation

Core station	Evaluation
Parramatta	A new metro station at Parramatta would reinforce its role as the metropolitan centre of the Central River City with access to reliable, high capacity public transport. This would support connectivity to employment, in an area where the number of jobs is expected to double over the next 20 years to 137,000 (Greater Sydney Commission, 2018a), and connect Parramatta to key employment centres across Greater Sydney. Sydney Metro West would also enable more customers to travel to Greater Parramatta from the east during the AM peak – supporting the development of Sydney as a multi-centric city.
Sydney Olympic Park	A metro station would enable full realisation of the Sydney Olympic Park lifestyle super precinct as a centre of recreation, entertainment, knowledge intensive jobs and higher-density living. Mass transit would support the 34,000 jobs and more than 23,000 residents which are expected to be located in the area by 2030 (Sydney Olympic Park Authority, 2018), and significantly enhance public transport connectivity.
The Bays	The Bays is set to be Sydney's new world-class destination and employment hub where 95 hectares of land is being regenerated. Sydney Metro West would enable The Bays to be developed to its full potential, with a focus on improved international competitiveness and knowledge based jobs.
Sydney CBD	A metro station in the Sydney CBD would allow easy access to the existing public transport network, Metro North West Line (opened in 2019), and Sydney Metro City & Southwest (currently under construction). Sydney Metro West would provide a direct connection from the Sydney CBD to current and future employment centres such as Greater Parramatta, Sydney Olympic Park and The Bays. It would also improve accessibility to Sydney's cultural, recreational and tourism attractions. There is also potential to provide congestion relief to the existing Town Hall and Wynyard stations.

3.6.2 Preliminary station locations

This phase identified and assessed station location options including connections to the T1 Western Line, T9 Northern Line and Sydney CBD. It included:

- Considering feedback from the first round of community and industry engagement
- Additional land use and transport modelling
- Scoping design, technical feasibility and engineering studies
- Considering feedback from key stakeholder workshops and working groups.

Westmead as a core station location

Westmead is home to one of the largest health, education, research and training precincts in Australia, and a key provider of jobs for Greater Parramatta and the Western Sydney region. Westmead provides direct health services to almost 10 per cent of Australia's population (Deloitte and Westmead Alliance, 2016). The catchment extends across Western Sydney and NSW, and throughout Australia. By 2026, the Westmead precinct will have over 2.8 million outpatient visits and over 160,000 emergency department presentations every year (Greater Sydney Commission, 2018a).

Westmead is an engine for health innovation and a major contributor to the Australian Government's national innovation and science agenda. Westmead produces world-leading scientists and analysts, and is home to successful health research collaborations, including translational research that aims to 'translate' research into meaningful health outcomes.

The Westmead health and education precinct spans more than 75 hectares and comprises over 400,000 square metres of high-end health-related developments, including four major hospitals, three world-leading medical research institutes, and the largest research-intensive pathology service in NSW.

Servicing the precinct with metro would provide a significant opportunity to underpin the new vision for Westmead by offering improved accessibility to and from the precinct, and attracting global practices and businesses. Westmead was therefore added as a core station location.

Connecting with the T1 Western Line – Westmead and Parramatta paired assessment

A metro station interchanging with the T1 Western Line would offer significant relief to existing T1 services, could provide customers with faster travel times and expand the 30-minute catchment for Greater Parramatta. A connection along the T1 Western Line may facilitate land use change with residential and employment growth opportunities, and provide wider accessibility and journey time savings across Greater Sydney.

A total of seven station option combinations were investigated including one single station option. Table 3-3 provides a summary of the station combinations evaluated. Figure 3-1 shows the shortlisted options in Westmead and Parramatta.

Table 3-3: Westmead and Parramatta – preliminary station location options evaluation

Locality	Preliminary evaluation	Shortlisted
Westmead North and Parramatta Station	This option would provide a station in Westmead North and one at the existing Parramatta Station where it would interchange with the T1 Western Line, T5 Cumberland Line and the T2 Inner West and Leppington Line. This option would relieve the busy T1 Western Line at Parramatta, serving the greatest number of existing Sydney Trains rail customers and providing an interchange with the existing bus network. This option would enable a metro station at Westmead to be closer to the health precinct and support delivery of the Westmead health and education super precinct. It would also offer customers an opportunity to transfer to and from Parramatta Light Rail.	Yes
Westmead Station and Parramatta CBD	This option would provide an interchange with T1 Western Line services at the existing Westmead Station and a new metro station in the Parramatta CBD. A new metro station in the northern part of the commercial district of Parramatta, in the heart of the Parramatta CBD, would serve the greatest number of jobs and provide fast and efficient connections with the Sydney CBD. It would create a second gateway to Parramatta, reinforcing its status as the Central River City. A new transport node could be established around a new station, providing much needed relief to the existing Parramatta Station and bus layover areas. This option would offer the opportunity to create a high-quality interchange for customers at Westmead with the T1 Western Line and T5 Cumberland Line, T-way bus services and Parramatta Light Rail. A new metro station at the existing Westmead Station would improve accessibility to the Westmead health and education super precinct, while also supporting renewal of the Westmead South residential precinct.	Yes
Parramatta Station only	With only one metro station at Parramatta, this option would create pressure on the constrained Parramatta Station and would not serve the health and education precinct at Westmead.	No
Westmead Station and Parramatta Station	Duplicating connections to the T1 Western Line at both existing stations would dilute the opportunity to reinforce the Parramatta CBD or serve the health and education precinct at Westmead and relieve the T1 Western Line.	No
Westmead North and Parramatta CBD	Although this option would both reinforce the Parramatta CBD and serve the health and education precinct at Westmead, it would not provide a direct connection with the T1 Western Line and therefore would not provide relief to the existing Sydney Trains suburban rail network.	No
Westmead Station and South Parramatta	A South Parramatta station could support additional housing supply in southern Parramatta, however would be at a further distance to the core activity of the Parramatta CBD (relative to other options considered). As such, it would not support the development of the Parramatta CBD.	No
Westmead North and South Parramatta	This option would not provide a direct connection with the T1 Western Line and therefore would not provide relief to the existing Sydney Trains suburban rail network. This option would also not support the development of the Parramatta CBD.	No

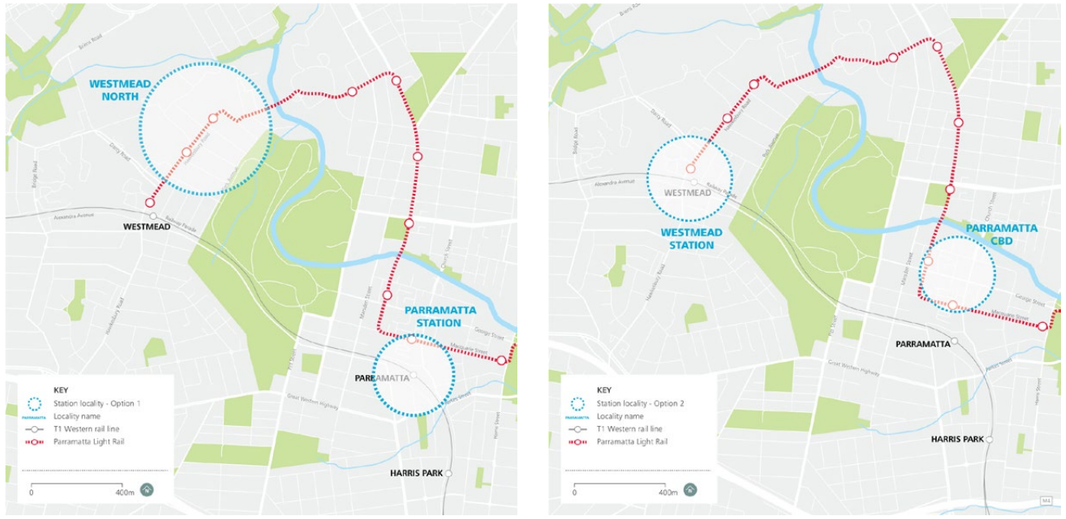

Figure 3-1: Shortlisted options to connect with the T1 Western Line and Greater Parramatta

Between Parramatta and Sydney Olympic Park – Greater Parramatta to the Olympic Peninsula area

Seven station locality options were investigated between Parramatta and Sydney Olympic Park. Table 3-4 outlines the station locality options which were evaluated.

Table 3-4: Greater Parramatta to the Olympic Peninsula – preliminary station location options evaluation

Locality	Preliminary evaluation	Shortlisted
Rydalmere	A metro station in Rydalmere could support urban renewal opportunities within the station catchment, including education, residential and mixed-use employment. Rydalmere could provide customer benefits to a growing catchment and transport integration with links to the Parramatta Light Rail and bus routes along Victoria Road delivering improved accessibility. A station in this locality may not align with the NSW Government's current strategic land use vision to retain essential urban services in this area (Greater Sydney Commission, 2016). Rydalmere is currently being assessed as a strategic station location (refer to Section 3.6.4).	Yes
Camelia	A new metro station could be located in the future Camellia Town Centre, offering an opportunity for an interchange with the future Parramatta Light Rail and supporting urban renewal. This option would present considerable constructability challenges in relation to contamination and flooding.	Yes
North Auburn	North Auburn would provide some support for mixed use development along Parramatta Road. However, this option would present significant constructability-related challenges associated with likely contamination and the existing road network, and the alignment would limit the ability to efficiently provide a station location in Parramatta.	No
Ermington	This option could support an increase in dwelling and population, although substantial uplift in this locality is not identified in strategic plans. This option would also result in a less efficient alignment between Sydney Olympic Park and Greater Parramatta, resulting in longer travel times for customers.	No
Silverwater	A station in this locality would not align with the Government's current strategic land use vision to retain essential urban services in this area (Greater Sydney Commission, 2016).	No

Locality	Preliminary evaluation	Shortlisted
Newington	While this option would create a new rail catchment area and support travel time savings, a station in this locality would not align with the current strategic land use vision for this area which seeks to retain the existing residential community without any significant increase in density, enabling the retention and protection of essential industrial and urban services land in adjoining Silverwater (Department of Planning and Environment, 2017a).	No
North Lidcombe	A station in this locality would not align with the Government's current strategic land use frameworks, which seek to retain existing urban services (Greater Sydney Commission, 2016). This option would have a highly constrained catchment due to transport and geographic barriers, and presents significant constructability-related challenges.	No

The evaluation identified that Camellia and Rydalmere could deliver significant benefits, particularly in relation to urban renewal, and were subject to further analysis. The Camellia and Rydalmere localities are shown on Figure 3-2.

While Camellia and Rydalmere were initially found to be the preferred locations from the options assessed in this area, it was determined that further analysis of this area was required due to:

- The strategic vision for land use in the area broadly between Parramatta and Sydney Olympic Park is to retain industrial or urban services functions
- Community and stakeholder consultation and feedback during round two of engagement in 2018, particularly in relation to Silverwater and Newington.

The area between Parramatta and Sydney Olympic Park was therefore progressed to the strategic station options phase to further investigate the opportunity for a station. Information on further and ongoing assessment of station location options in this area is detailed in Section 3.6.4.

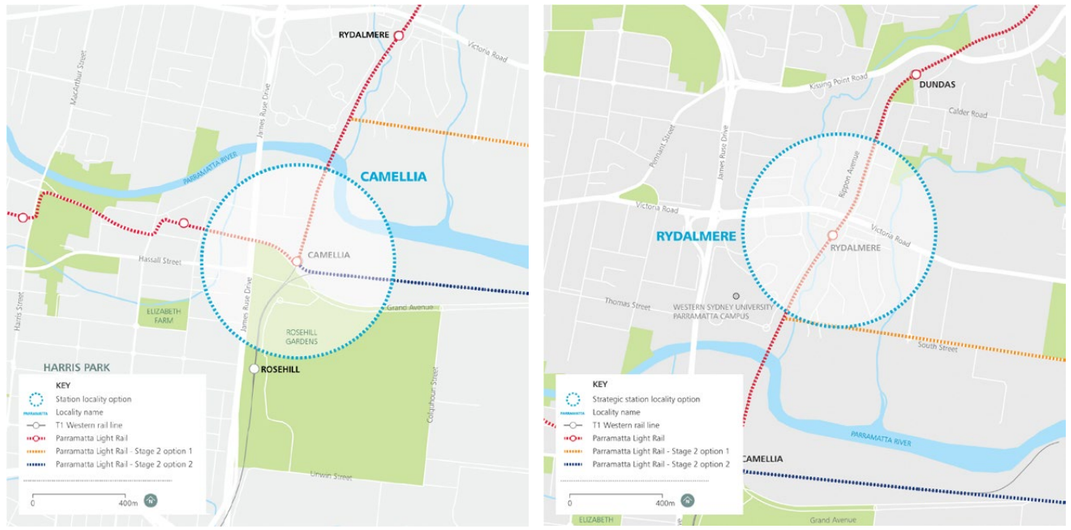

Figure 3-2: Greater Parramatta Olympic Park station location options taken forward from initial investigations

Connection with the T9 Northern Line

Providing a metro station that interchanges with the T9 Northern Line would offer significant relief to existing services, provide customers with faster travel times and expand the 30-minute catchment for Greater Parramatta. The station would provide an attractive interchange option for customers and extend the catchment of Sydney Metro West to Sydney's north. A connection along the T9 Northern Line may facilitate land use change with residential and employment growth opportunities, and provide wider accessibility and journey time savings across Greater Sydney.

Along the T9 Northern Line, four stations were subject to a preliminary station assessment. Of these four stations, two were shortlisted for further evaluation. Table 3-5 provides a summary of the station options evaluated.

Table 3-5: Connection to the T9 Northern Line – preliminary station location options evaluated

Locality	Preliminary evaluation	Shortlisted
Rhodes	A station at Rhodes would align with the objective of Rhodes as a strategic centre and would support a minor uplift in job and population. However there is less opportunity for urban renewal at this location (compared to other station localities) due to the geographic constraints. Rhodes is located on a peninsula, making a connection at this location challenging from a constructability point of view (associated with existing basements and water crossings), and impacts to the alignment, and therefore travel time for customers.	No
Concord West	A Concord West station location would provide opportunities for integration with the local bus network and would support some residential and employment growth, however would have a relatively small walking catchment due to large open spaces nearby.	Yes
North Strathfield	A North Strathfield station location would support urban renewal within the Homebush precinct redevelopment area. The station would reach a significant walking catchment and offer a more efficient alignment (and therefore improved travel times for customers travelling between Parramatta and the Sydney CBD).	Yes
Strathfield	A station at Strathfield would provide limited residential and jobs growth as high density development already surrounds the station, and the locality is not identified as a key employment centre. The existing Strathfield Station is constrained in terms of capacity and this option would duplicate the existing T1 Western Line services between Parramatta and the Sydney CBD.	No

The evaluation identified Concord West and North Strathfield could deliver significant benefits and were subject to further analysis. The two shortlisted options are shown on Figure 3-3.

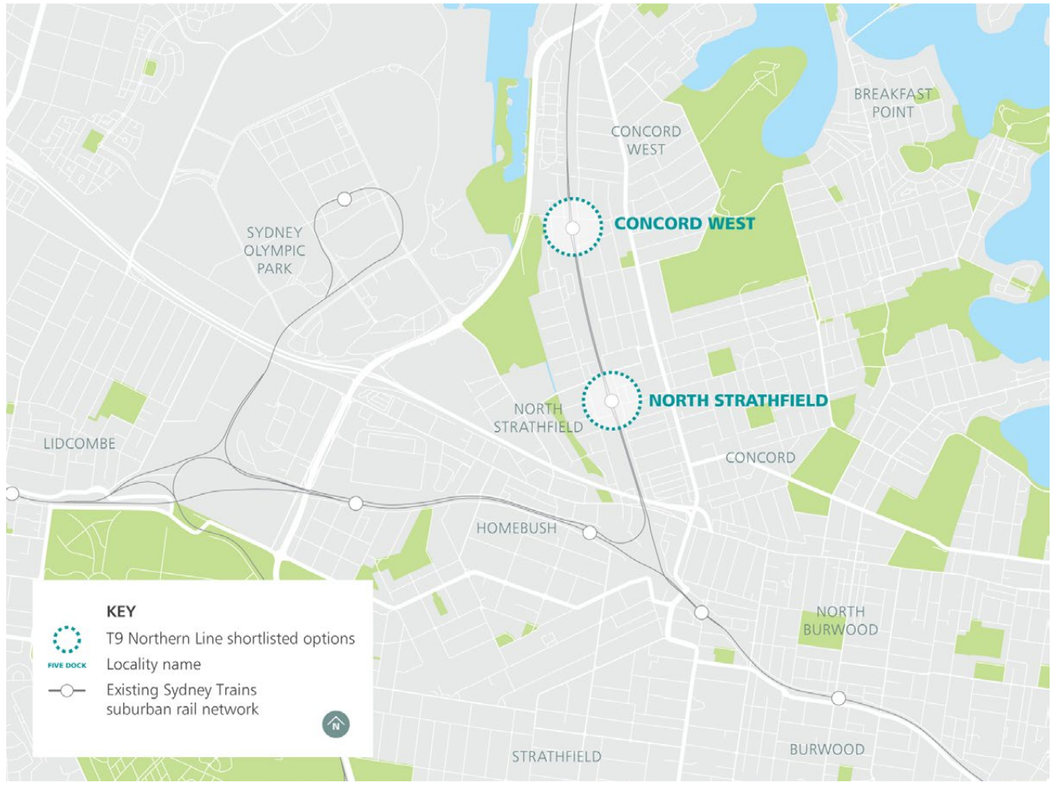

Figure 3-3: T9 Northern Line shortlisted options

Between the T9 Northern Line and The Bays

Currently, public transport accessibility between the T9 Northern Line and The Bays is largely limited to road-based transport. There are opportunities to provide customers with significant travel time improvements, connect more of the workforce to jobs within 30 minutes and integrate with the bus network.

Between the T9 Northern Line and The Bays, a total of 13 station options were assessed, three of which were taken forward to the next phase of evaluation. Table 3-6 provides a summary of the station combinations evaluated.

Table 3-6: T9 Northern Line to The Bays – preliminary station location options evaluated

Locality	Preliminary evaluation	Shortlisted
Concord	Concord is characterised by lower density residential land use with significant green space. There is limited employment activity within the locality and limited opportunity for residential and employment uplift. Heritage attributes and green space in the locality would also require careful consideration.	No
Mortlake	Mortlake is a peninsula constrained by the Parramatta River. There is limited employment activity within the locality. Recent medium density residential development and the presence of waterbodies and green space limit opportunities for employment and residential uplift in the locality. The location would present some constructability and deliverability challenges due to interaction with multiple water crossings, varied elevation (impacting station depth), and a potentially inefficient alignment.	No
Burwood North	The Burwood North locality is within the Parramatta Road Corridor Urban Transformation Strategy area and characterised by a mix of uses along Parramatta Road and along Burwood Road towards the Burwood strategic centre. A station at Burwood North could support employment growth and intensification of existing land uses in the surrounding catchment, with opportunities for residential growth. It would open a new rail catchment to provide customer benefits with a more frequent, reliable and fast mass transit service, and would provide an opportunity to integrate with the existing bus network. A station in this locality would offer a relatively efficient corridor alignment that supports efficient travel times between the Parramatta and Sydney CBDs.	Yes
Burwood	As the current level of Sydney Trains suburban rail service is high to Burwood, with the existing Burwood Station serviced by multiple lines, customers in the locality would receive relatively less improvement to service frequency, travel time and improved access compared to other station locations. As Burwood is located significantly south of The Bays and Olympic Park stations, the station location would result in an inefficient alignment and deliver longer travel times. In addition, intensive land use around the rail corridor would present constructability challenges including the potential to impact to existing rail services.	No
Kings Bay	Kings Bay is characterised by mixed land use on nearby Parramatta Road including residential, retail, light industrial and education. There is employment and mixed residential land use within the locality, with opportunity for employment uplift and planned renewal as part of the Parramatta Road Corridor Urban Transformation Strategy. The delivery of a metro station would provide customer benefits through a more frequent, reliable and fast service to an area that does not currently connect with mass transit, and presents a transport interchange opportunity with local bus services on Parramatta Road. A station in this locality would offer a corridor alignment that supports efficient travel times between the Parramatta and Sydney CBDs.	Yes
Five Dock	Five Dock is characterised by mixed land uses, including lower density residential and a local town centre on Great North Road. A metro station would provide customers with a more frequent, reliable and fast service to an area that is currently not serviced by mass transit. Five Dock is recognised as a location for bus interchange and active transport connectivity. A metro station in this locality could offer a relatively efficient corridor alignment that supports efficient travel times between the Parramatta and Sydney CBDs.	Yes
Ashfield	Ashfield would provide limited support for additional renewal and growth, as development is already occurring in the short and medium term. Ashfield is currently served by the T1 Western Line and other services at the existing Ashfield Station. This option would also result in an inefficient north-south alignment to connect to The Bays, which would increase travel times for customers.	No
Haberfield	Haberfield is characterised by lower density residential land use with limited employment activity within the locality and heritage attributes in the area. This locality would also have constructability and deliverability challenges due to interaction with the Rozelle Interchange (tunnel) and Hawthorne Canal. It would also have an inefficient alignment to The Bays, which would increase travel times.	No
Drummoyne	Drummoyne would offer limited residential and employment growth opportunities due to the geographic constraints of the peninsula. Drummoyne would present challenging constructability and deliverability due to interaction with multiple water crossings, the varied elevation in the locality that would impact station depth, and an inefficient alignment that would increase travel time between the two CBDs.	No
Lilyfield	Lilyfield is characterised by lower density residential land use, some green space and heritage which would limit the opportunity for urban renewal. The locality would present highly difficult constructability and deliverability due to interaction with the Rozelle Interchange and Hawthorne Canal. Initial investigations suggest this would require a very deep station, resulting in greatly increased access and interchange times for customers.	No

Locality	Preliminary evaluation	Shortlisted
Leichhardt North	Leichhardt North would present challenging constructability and deliverability due to interaction with the Rozelle Interchange and Hawthorne Canal. Initial investigations suggest that this would require a very deep station, resulting in greatly increased access and interchange times for customers.	No
Leichhardt	Leichhardt is characterised by lower density residential land use, limited employment activity within the existing locality, and limited scope for employment uplift due to the heritage value of the area. It is also currently served by light rail along its western boundary. The locality would present challenging constructability and deliverability due to interaction with the Rozelle Interchange and Hawthorne Canal.	No
Annandale North	Annandale North presents less opportunity to connect to employment activity, and growth in employment and population at this locality. Any station option would also require careful consideration of heritage conservation areas. This option would also result in an inefficient north-south alignment to connect to The Bays, which would increase travel times for customers.	No

The evaluation identified the station localities of Burwood North, Kings Bay and Five Dock could deliver significant benefits and were subject to further analysis. These options are shown on Figure 3-4.

Figure 3-4: Shortlisted station locations between T9 Northern Line and The Bays

Connecting into the Sydney CBD

The Sydney CBD is one of the most productive and well-connected areas in Australia. A connection to the Sydney CBD would:

- Connect customers to high value employment and support efficient business-to-business links
- Offer greater choice for customers and travel time savings to the Sydney CBD
- Enable new interchange opportunities with the existing suburban and intercity rail network and the future Sydney Metro network
- Provide relief to existing Sydney CBD stations.

Further investigation is currently underway to identify an optimum station location within the Sydney CBD. The location of a station with the Sydney CBD and an analysis of potential options would be presented as part of the assessment for a future stage.

Outcome of preliminary station locations assessment

The preliminary station locations assessment concluded:

- Westmead was included as a core station location
- The shortlisted pairs for station locations at Westmead and Parramatta and to connect to the T1 Western Line were Westmead North/Parramatta Station and Westmead Station/Parramatta CBD
- No obvious station location was identified for the area between Parramatta and Sydney Olympic Park. This area was therefore carried forward for further assessment as part of the strategic station options phase
- The shortlisted locations for the T9 Northern Line connection were Concord West and North Strathfield
- The shortlisted locations for the area between the T9 Northern Line and The Bays were Burwood North, Kings Bay and Five Dock
- The preferred location for the Sydney CBD connection requires further investigation to identify the optimum location.

3.6.3 Shortlisted station locations

Detailed assessment of shortlisted stations against the network objectives was carried out.

Input to these assessments included additional land use and transport modelling, detailed technical design and engineering assessments, urban design and placemaking assessments, customer testing, a second round of community and industry consultation, and multiple meetings and workshops with key stakeholders.

The performance of each of the shortlisted station options was assessed in detail against the Sydney Metro West objectives and scored as 'strong alignment' (green), 'some or neutral alignment' (orange) or 'no or negative alignment' (red). The results are summarised in Table 3-7 and a discussion of each assessment is provided below.

Table 3-7: Performance of shortlisted stations against Sydney Metro West objectives

Station location option	Evaluation criteria						
	Customer benefits	Strategic land use and transport alignment	Productivity & jobs	Housing supply	Urban renewal & place-making	Transport integration	Deliverability & value for money
Station locations in Westmead and Parramatta and T1 Western Line connection							
Westmead Station & Parramatta CBD	🟢	🟢	🟠	🟢	🟢	🟢	🟠
Westmead North & Parramatta Station	🟠	🟠	🟢	🟢	🟢	🟠	🔴
T9 Northern Line connection							
Concord West	🟠	🟠	🟠	🟠	🟠	🟢	🟢
North Strathfield	🟢	🟠	🟢	🟢	🟢	🟢	🟠
Between the T9 Northern Line and The Bays							
Burwood North	🟢	🟢	🟢	🟢	🟢	🟠	🟠
Five Dock	🟢	🟠	🟢	🟠	🟠	🟢	🟠
Kings Bay	🟢	🟠	🟠	🟠	🟢	🟠	🟠

Station locations in Westmead and Parramatta and connecting with the T1 Western Line

The assessment of the Westmead Station and Parramatta CBD pair identified that this option would:

- Support the vision for a metropolis of three cities (Greater Sydney Commission, 2018a) by reinforcing Parramatta with a multi-nodal transport offering
- Provide relief to the existing Parramatta Station
- Deliver strong place-based outcomes in Parramatta CBD by supporting the delivery of part of the Civic Link between the existing Parramatta Station and the cultural precinct along the Parramatta River
- Substantially relieve the T1 Western Line through the provision of a metro station interchanging with the existing Sydney Trains suburban rail services at Westmead
- Serve the health and education precinct to the north as well as the planned precinct to the south
- Offer a new multimodal transport interchange at Westmead, integrating with Parramatta Light Rail, T-way buses and Sydney Trains suburban rail services.

The assessment of the Westmead North and Parramatta Station pair identified that this option would:

- Result in increased pressure on the existing Parramatta Station and bus layover, requiring significant capacity increase
- Have major constructability challenges due to the presence of sensitive receivers surrounding the hospital precinct at Westmead North and the need for a substantial intervention to the existing Parramatta Station
- Offer benefits to customers who already experience an existing high level of service in the catchment of Parramatta Station, rather than extending the mass transit catchment to the north of the Parramatta CBD
- Potentially pose limitations on construction of future mass transit corridors in Parramatta indicated in the Future Transport Strategy 2056 (Parramatta to Epping, Parramatta to Kogarah).

Subsequently, Westmead Station and Parramatta CBD was identified as the preferred option to connect to the T1 Western Line and serve Greater Parramatta.

T9 Northern Line connection

The assessment identified that a metro station at North Strathfield would support and facilitate urban renewal within the Parramatta Road Corridor Urban Transformation Strategy Homebush Precinct and enable an efficient tunnel alignment into Sydney Olympic Park metro station.

Relative to the North Strathfield option, a metro station at Concord West would provide less support for growth in homes and jobs within a walkable catchment of the station. Additionally, a metro station at Concord West would result in a less efficient alignment to Sydney Olympic Park metro station and potentially increase overall travel times between Parramatta and the Sydney CBD.

As a result, North Strathfield was identified as the preferred station to connect to the T9 Northern Line.

Between the T9 Northern Line and The Bays

The assessment identified that:

- A metro station at Burwood North would create a multi-nodal, integrated transport offering along Burwood Road with two mass transit nodes supporting the Burwood strategic centre to the south and the Parramatta Road Corridor Urban Transformation Strategy area to the north. The station would offer customers significant travel time savings as well as improved connections with key bus corridors coming from the local peninsulas of Concord and Abbotsford as well as Burwood Road
- A metro station at Five Dock would open a new rail catchment and deliver significant travel time savings of more than 30 minutes for customers travelling to the Sydney CBD and about 30 minutes for customers travelling to the Parramatta CBD. Five Dock could provide an efficient bus to metro interchange and help relieve the bus network along Parramatta Road, Victoria Road, the Drummoyne peninsula and parts of the Inner West entering the Sydney CBD
- The Burwood North and Five Dock station location options present an opportunity to function as a pair of stations. The delivery of both stations would service a greater catchment over this length of the corridor
- Relative to the Burwood North and Five Dock options Kings Bay would support a smaller station catchment (as its catchment is limited by Canada Bay and surrounding green space), deliver a smaller increase in productivity and have less opportunity for integration with the wider transport network
- Kings Bay would not support additional intermediate locations, as its catchment would overlap significantly with both the Burwood North and Five Dock options, limiting the opportunity to service a larger catchment. The majority of the catchment serviced by a Kings Bay station would be able to be serviced with a combination of Burwood North and Five Dock metro stations.

Burwood North and Five Dock were identified as preferred the options for the area between the T9 Northern Line connection and The Bays.

Outcome of shortlisted station locations assessment

The assessment of shortlisted metro station locations identified the following preferred station options:

- Westmead Station and Parramatta CBD for the Greater Parramatta area and to connect to the T1 Western Line
- North Strathfield as the T9 Northern Line connection
- Burwood North and Five Dock for the area between the T9 Northern Line and The Bays.

Design refinement for preferred station locations

The preferred metro station locations are further described in Chapter 6 (Concept description). During the development of preferred station designs a range of factors would be considered, including:

- Orientation of station buildings and associated infrastructure to provide effective and efficient access for customers and integration with surrounding land uses
- Constructability
- Potential opportunities for future integrated station and precinct development above or adjacent to the station and how this is considered in design.

Refinements to the Stage 1 station configurations and construction footprints are detailed in Section 3.7.1, and further described in detail in Chapter 6 (Concept description).

3.6.4 Strategic station options

An additional phase is ongoing to determine optional station locations to be included as part of Sydney Metro West.

The strategic station options phase includes further evaluation of potential station locations between Parramatta and Sydney Olympic Park and at Pyrmont. Further investigation and analysis is required to determine the inclusion of additional station options as part of the Concept. This would include analysis of community and stakeholder feedback (refer to Appendix C (Stakeholder and community feedback) for a summary of feedback received), additional land use and transport modelling, technical considerations, and consideration of strategic planning at precincts under investigation.

Between Parramatta and Sydney Olympic Park

As identified during the preliminary station location assessment, further assessment of a potential station between Parramatta and Sydney Olympic Park was required.

This assessment involved collaboration with the Department of Planning, Industry and Environment to investigate the long term land use outcomes between Parramatta and Sydney Olympic Park, and considered feedback received during the community consultation period in April 2018.

A summary of the station locations options assessment for the area between Parramatta and Sydney Olympic Park is provided in Table 3-8.

Table 3-8: Performance of station options between Parramatta and Sydney Olympic Park against the network objectives

Station location option	Evaluation criteria						
	Customer benefits	Strategic land use and transport alignment	Productivity & jobs	Housing supply	Urban renewal & placemaking	Transport integration	Deliverability & value for money
Rydalmere	🟢	🟢	🟢	🟢	🟢	🟡	🟡
Camelia	🟢	🟡	🟡	🟡	🟡	🟡	🔴
Rosehill	🟢	🟡	🟡	🟢	🟡	🟡	🔴
Silverwater East	🟡	🟡	🟢	🔴	🔴	🟡	🟡
Silverwater West	🟡	🟡	🟢	🟡	🟡	🟡	🟡

The assessment shows that the preferred option for a station between Parramatta and Sydney Olympic Park is at Rydalmere. A station at Rydalmere would support the growth and development of a diverse and connected Parramatta CBD, and would provide significant opportunity for urban renewal, housing and employment growth while maintaining the existing essential urban services land use in the broader area.

While a Rydalmere station option would provide the benefits described, it would also result in a longer alignment, an associated greater cost and increased travel times for some metro customers. The feasibility and affordability of this option is currently being investigated as a strategic station option and does not form part of the Concept at this stage.

Pyrmont

Pyrmont had been identified as a strategic station option which has potential to strategically enhance Sydney Metro West.

A station at Pyrmont would serve the commercial, residential and entertainment precinct in the locality. It also has the potential to serve some of the catchment area for the existing Town Hall Station. A station at Pyrmont would also provide an opportunity to improve accessibility to existing employment and various attractions.

The station location and configuration of Pyrmont Station would seek to:

- Provide customers with access to the commercial and entertainment precinct, with key destinations including the International Convention Centre and Sydney Fish Markets, as well as a pedestrian connection along Pyrmont Bridge to the western side of the Sydney CBD
- Enable connections between the Sydney CBD, Pyrmont and The Bays to support the creation of an expanded and connected Sydney CBD
- Deliver a direct rail service to a catchment not currently serviced by mass transit, and an opportunity to create an interchange with Inner West Light Rail and bus services.

A metro station at Pyrmont would present some constraints and challenges in relation to:

- Barriers to pedestrian movement which may constrain the catchment of a metro station – including steep topography throughout the peninsula and around the waterfront; retaining walls and cuttings around the L1 Dulwich Hill light rail; major at-grade intersections at Fig Street and Bank Street entrances to the Western Distributor
- Minimising or avoiding impacts on heritage items in the area, including the Union Square conservation area, as well as relocation of major utilities
- Alignment diversion and speed restrictions between The Bays Station and Sydney CBD Station locations may impact travel times.

The feasibility and affordability of the Pyrmont Station option is currently being investigated as a strategic station option and does not form part of the Concept at this stage.

3.7 Technical design and construction alternatives

3.7.1 Stage 1 station construction sites

As part of the development of Stage 1, station locations and construction footprints have been subject to further refinement taking into account expected future operational requirements for the stations, as well as considering the key construction requirements for the tunnel and stations. The key factors that have influenced the construction footprint for each Stage 1 station are summarised in Table 3-9 and each construction footprint is described in detail in Chapter 9 (Stage 1 description). In all cases the station construction footprints have been reduced as much as practicable to minimise the need for land acquisition, minimise disruption to local communities and to minimise environmental impacts.

Table 3-9: Stage 1 station and construction footprint optimisation analysis

Stage 1 Station	Factors influencing station and construction footprint
Westmead	• Cut-and-cover type station construction • Minimisation of disruption to services on the T1 Western Line during construction • Construction site required to accommodate tunnel boring machine dive site and major spoil extraction and management activities • Minimisation of impacts to sensitive medical receivers to the north of the existing Westmead Station.
Parramatta	• Cut-and-cover type station construction • Construction arrangements to retain access for surrounding businesses • Minimisation of construction and operational impacts on nearby heritage items.
Olympic Park	• Cut-and-cover type station construction • Coordinated station orientation and operational access arrangements with Sydney Olympic Park Master Plan • Provision of connections with the planned Parramatta Light Rail Stage 2 • Minimisation of construction and operational impacts on nearby heritage items • Construction site required to accommodate tunnel boring machine extraction.
North Strathfield	• Cut-and-cover type station construction • Minimisation of disruption to the T9 Northern Line during construction • Coordinated access to the T9 Northern Line • Minimisation of land acquisition of established residential and commercial properties.
Burwood North	• Cut-and-cover type station construction • Minimisation of land acquisition of established residential properties • Minimisation of construction impacts on surrounding road network including Parramatta Road, Burwood Road and Loftus Street • Enabling of future operational access to the station from both sides of Parramatta Road.
Five Dock	• Binocular cavern type station construction • Minimisation of land acquisition of established residential properties.
The Bays	• Cut-and-cover type station construction • Construction site required to accommodate tunnel boring machine dive site and major spoil extraction and management activities • Coordination of construction works with other infrastructure projects – including WestConnex and Western Harbour Tunnel, especially in relation to construction site area, construction access traffic management • Minimisation of construction impacts on surrounding port users and the heritage listed White Bay Power Station.

3.7.2 Tunnel configuration alternatives

Sydney Metro West would provide a new metro rail line comprising two underground rail tracks to be operated in both directions. The rail line could either be housed within a twin or single tunnel configuration. A twin tunnel configuration involves housing each rail track in a separate tunnel, whereas a single tunnel configuration would accommodate both rail tracks within a larger, single bored tunnel.

The majority of the tunnel alignment of Sydney Metro West would be underground and would be constructed using tunnel boring machines which excavate a circular tunnel profile. There are three main options for tunnel configuration which have been assessed concentrating on circular tunnel profiles. These are shown on Figure 3-5 and are:

- Twin-tube (two, single-track tunnels)
- Single-tube side-by-side (single, side-by-side, twin-track tunnel)
- Single-tube vertically stacked (single, vertically-stacked, twin-track tunnel).

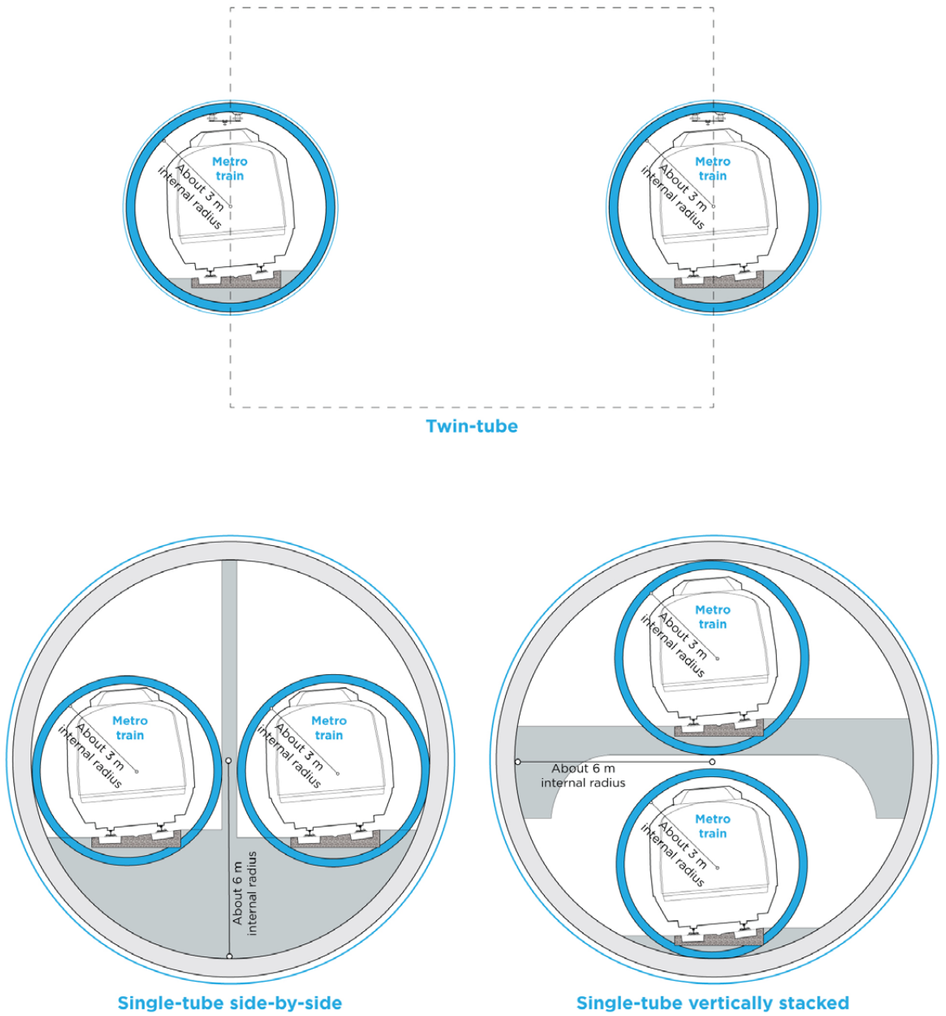

Figure 3-5: Tunnel configuration options

A qualitative assessment was undertaken for these options focussing on the following engineering requirements:

- Geotechnical risk and challenge, for example size and volume of tunnel excavation, and tunnel alignment profile and diameter
- Impact to the surrounding built environment and properties
- Availability of suitable size tunnel boring machines in the market
- Maintenance and operational considerations such as emergency and operation access within and between running tunnels
- Size of tunnel internal space provided for rolling stock, tunnel services, overhead electrification, and structural gauge requirement, in particular for necessary height provided from the tunnel invert to mean rail level
- Tunnel ventilation accommodation and implications
- Connecting the tunnels to the station excavations.

From the assessment, the twin-tube tunnel configuration is the preferred option due to the following benefits:

- More efficiently facilitates a full range of station typologies (binocular, island platform cavern and stacked platform cavern)
- Provides an effective fire and life safety strategy
- Minimises geotechnical and construction program risks
- Allows safer and easier access to undertake maintenance
- Generates less tunnel spoil and less impact to the surrounding built environment such as from construction vibration
- Allows greater alignment flexibility in heavily constrained underground environments.

3.7.3 Stabling and maintenance facility alternatives

A stabling and maintenance facility to support an efficient, safe and reliable metro network would be required for Sydney Metro West.

Initial assessment included consideration of a long list of location options for a stabling and maintenance facility. These included:

- Camellia/Rosehill
- Northmead
- Silverwater
- Rydalmere
- Clyde
- Options further west, including Girraween and Greystanes.

Following initial assessment, Northmead, Silverwater and Rydalmere were not taken forward for further investigation. These options would impact on the viability of the remaining land use and businesses in the localities. Additionally, sites in Northmead and Rydalmere have been identified for future development, which a stabling and maintenance facility may not support.

Options further west, including Girraween and Greystanes, were also not taken forward for further assessment. These sites would be located about five kilometres west of the terminus station at Westmead. This would result in inefficient operations and 'dead running' of rolling stock (where trains operate without carrying passengers, generally to and from a stabling facility).

Following initial assessment, the former Shell refinery site (now the Viva Energy property) in the Camellia/Rosehill area and Clyde were shortlisted as the potential locations for the stabling and maintenance facility. The Camellia/Rosehill location would have a relatively low impact on existing properties and land uses, however it would present challenges in relation to flooding and previous substantial contamination, which may pose constraints to construction methodology, program, cost, and worker health and safety.

The Clyde site would also require management of flooding and existing contamination, however these issues can be more easily managed when compared to the Camellia/Rosehill location. However, this location would potentially affect a larger number of existing properties and land uses, when compared to the Camellia/Rosehill location (consideration and assessment of the potential impacts to existing properties and land uses is provided in Chapter 14 (Property and land use – Stage 1), Chapter 16 (Business impacts – Stage 1) and Chapter 17 (Social impacts – Stage 1)). On balance, the Clyde site was found to be the least constrained of all options assessed (when considering construction, program, cost and worker health and safety) and would provide for the efficient operation of the line. Therefore, Clyde was identified as the preferred locality for the stabling and maintenance facility.

3.7.4 Tunnel construction alternatives

Principles influencing the selection of tunnel boring machine launch and retrieval sites include:

- Availability of land to support tunnel boring machine launch activities, with a preference for government-owned and underutilised land, in order to minimise the need for property acquisition
- Ability to optimise tunnelling distances and the number of tunnel boring machines required. Distances around 10 kilometres or less are generally more manageable, reduce the need for tunnel boring machine repairs and maintenance, and can provide a short transportation distance for segments, materials and workers from the support site to the tunnelling face
- Access to arterial roads from the site to enable efficient transportation of tunnel boring machines, segments, spoil and other materials, and minimise impact to local streets
- Ability to minimise impacts to sensitive receivers, the road network and residential areas
- Topography, proximity of adjacent infrastructure, and engineering requirements
- Co-location with future operational infrastructure to limit property acquisition requirements.

Taking into account these principles, preferred options were selected for tunnel boring machine launch and retrieval sites. Key options also considered how to optimise the tunnelling strategy, by focussing on locations at either end of the tunnels and locations around the middle of the tunnel alignment.

Tunnel boring machine launch and retrieval sites

The following were identified as either launch or retrieval sites:

- Westmead metro station construction site as it would be at the western end of Stage 1
- The Bays Station construction site as it would be at the eastern end of Stage 1
- Sydney Olympic Park metro station construction site as it would provide an optimised tunnelling strategy by providing a relatively even distance for tunnel boring machine drives to the east and west.

Analysis identified the following as the preferred tunnel boring machine launch and retrieval sites:

- The Bays Station construction site was identified as a preferred launch site, as it would provide sufficient land to support tunnel boring machine launch activities and would minimise impacts on sensitive receivers (there are no residential properties within the immediate vicinity). Road network impacts could also be minimised, with the opportunity for deliveries and spoil removal by barge
- The Sydney Olympic Park metro station construction site was identified as a preferred retrieval site, as it would provide sufficient land to support tunnel boring machine retrieval activities due to its open cut-and cover construction method and surrounding wide modern streets. The site would minimise impacts on residential properties relative to other nearby site options and would have direct access to the arterial road network and the M4 Motorway
- Westmead metro station construction site would be the other preferred launch site, providing sufficient land to support tunnel boring machine launch activities and convenient access to the arterial road network and the M4 Motorway.

Sydney Metro would investigate options for managing the tunnel boring machines at the end of the line in the Sydney CBD once the location of the Sydney CBD Station is determined.

Concrete segment facility

A concrete segment facility would be required to support the tunnel construction works.

The Clyde stabling and maintenance facility was selected as the preferred location for the concrete segment facility as it provides sufficient land, is located in an existing industrial zone and has significant distances to sensitive residential receivers, thereby minimising environmental amenity impacts associated with the facility.

3.7.5 Services facilities

Fresh air tunnel ventilation for Sydney Metro West would generally be provided at the proposed stations. However, additional facilities would be required where there are longer distances between stations. Based on the current design two services facilities are required between Parramatta and Sydney Olympic Park and one between Five Dock and The Bays.

The process for selecting potential sites for services facilities involved considering the suitability of the Sydney Metro West construction sites located directly above the tunnels. Constructing the services facilities within the existing construction sites would eliminate the need to acquire additional land. Where existing construction sites were not deemed suitable, existing public land or vacant land was identified as preferable for the services facility.

Between Parramatta and Sydney Olympic Park

Two services facilities are required between Parramatta and Sydney Olympic Park. Analysis identified that:

- The Clyde stabling and maintenance facility construction site provides an opportunity for a services facility located within an industrial area and adjacent to other operational infrastructure
- An additional site directly above the tunnel alignment was identified in Silverwater. This site is currently vacant land and is within an industrial area.

Between Five Dock and The Bays

The location of the services facility is currently being investigated. The following locational and design criteria would be used as part of determining the preferred location as described in Chapter 9 (Stage 1 description):

- The site would not be located on existing residential land
- There would be no removal of vegetation that constitutes a locally occurring Plant Community Type
- There would be no direct impacts on items listed on the State Heritage Register
- There would be no direct impacts to significant elements of any locally listed heritage items
- The construction of the facility would not result in any negative impacts to groundwater users, groundwater dependent surface flows or groundwater dependent ecosystems.

In addition to the above, the facility would need to achieve the performance outcomes set for the Concept – refer to Chapter 8 (Concept environmental assessment).

3.8 Barge or ship transport

Three options have been evaluated by Sydney Metro for the transport of spoil from Stage 1 construction sites.

Options investigated were:

- Road transport
- Rail transport
- Barging and shipping transport.

An assessment of each option is provided below.

The transport and management of spoil is discussed further in Chapter 10 (Transport and traffic – Stage 1) and Chapter 24 (Spoil, waste management and resource use – Stage 1).

3.8.1 Road transport

Road transport would be the primary transport method from most construction sites. Road transport was considered feasible for all construction sites due to their location directly adjacent to the existing road network, in particular the proximity to the motorway and arterial road network.

Haulage routes have been developed in consultation with relevant sections of Transport for NSW and Sydney Coordination Office and have aimed to minimise the use of local roads and use the most efficient route to the arterial road network. Further information regarding the haul routes to and from each site are provided in Chapter 10 (Transport and traffic – Stage 1).

3.8.2 Rail transport

Rail transport options were investigated for the Westmead metro station, Clyde stabling and maintenance facility, North Strathfield metro station and The Bays Station construction sites due to their proximity to the rail network.

Rail transportation of spoil from the Stage 1 construction sites would require the following elements:

- Access to the Metropolitan Freight Network, the Southern Sydney Freight Line and/or the Northern Sydney Freight Corridor
- Adequate train storage at (or very close to) the construction site, including a siding to store at least one train
- Train loading facilities and/or stockpiling space.

Access to the freight network from these locations would require substantial track works and signalling upgrades, road transport from the spoil generation site to train loading facilities, and/or shared use of the suburban and/or light rail networks. At some locations, spoil would need to be triple handled (at the generation site, at the loading site and at the unloading site). At both Westmead metro station and North Strathfield metro station construction sites, substantial property acquisition and/or road closures would be required to secure space for train storage, loading and stockpiling.

Based on the above constraints, rail transport was not considered a viable option for Stage 1.

3.8.3 Barge or and ship transport

Barge transport options were investigated for the Clyde stabling and maintenance facility and The Bays Station construction sites due to their respective proximity to Parramatta River and Sydney Harbour.

Barging of spoil from The Bays Station construction site could be achieved by using the existing port areas at White Bay. Spoil could be barged from this construction site to Camellia for re-use opportunities at the Clyde stabling and maintenance facility construction site or for other local re-use opportunities. Spoil could be unloaded from barges at Camellia using barging infrastructure developed for Sydney Metro City & Southwest.

Spoil could also be barged and/or shipped from the Clyde stabling and maintenance facility and The Bays Station construction sites outside of Sydney Harbour to locations such as Port Kembla or Port Newcastle for regional re-use opportunities.

Barge transport of spoil to and from these construction sites may be feasible at this site subject to further investigations and/or approvals and the agreement of NSW Ports and/or Port of Newcastle. Further investigations would consider the following elements:

- Restrictions on barge or ship transport due to factors such as low tides within Parramatta River, or adverse weather conditions outside of Sydney Harbour
- Timing of fill requirements for re-use opportunities
- Suitability of spoil generated for re-use opportunities
- Construction traffic impacts of any road or rail transport required to deliver spoil from the barging sites to the final destinations.

Barged spoil could also be disposed of at sea (offshore). Licenced disposal grounds are in operation off Sydney Harbour and Newcastle. Offshore disposal would be conducted outside NSW and is regulated under the *Environment Protection (Sea Dumping) Act 1981*. Material would be required to satisfy the requirements of the National Assessment Guidelines for Dredging (Department of Environment, Water, Heritage and the Arts, 2009) before being considered suitable for disposal at the designated offshore disposal site.

Further consideration of barge options would be carried out during further construction planning for Stage 1 and in future stages of Sydney Metro West.