Chapter 2

Development and alternatives

2 Development and alternatives

This chapter describes an overview of the Concept development and alternatives and the evaluation carried out to determine the strategic station option at Pyrmont, station location options, tunnel alignment, tunnel support and spoil transport for this proposal.

2.1 Overview of the Concept development and alternatives

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 with Clyde identified as the preferred locality for the stabling and maintenance facility
- Analysis of options for the approach to tunnelling.

Development has been carried out in consultation with stakeholders and the community. These are discussed in Chapter 3 of the *Sydney Metro West Environmental Impact Statement – Westmead to The Bays and Sydney CBD* (Sydney Metro, 2020a).

As part of the development process for Sydney Metro West, a range of potential strategic alternatives to Sydney Metro West were considered. 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.

This evaluation concluded that a Sydney Metro service with about nine to 10 stations between Greater Parramatta and the Sydney CBD was the preferred option as it could achieve a balance between travel times and an optimal number of stations to service a large catchment.

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.

The *Sydney Metro West Environmental Impact Statement – Westmead to The Bays and Sydney CBD* (Sydney Metro, 2020a) noted that the preferred location for a Sydney CBD Station was being investigated and Pyrmont was identified as a strategic station option with the potential to strategically enhance Sydney Metro West.

2.2 Development and alternatives for this proposal

The development process for the major civil construction work between The Bays and Sydney CBD proposal has specifically included:

- Analysis of Pyrmont Station as a strategic station option
- Analysis of options of station locations within Pyrmont and Sydney CBD
- Further optimisation of station construction sites
- Consideration of tunnel alignment
- Analysis of options for the approach to tunnelling and tunnelling support
- Consideration of spoil transport alternatives
- Investigations into potential future extension of the Sydney Metro West line.

2.2.1 Strategic station option at Pyrmont

The *Sydney Metro West Environmental Impact Statement – Westmead to The Bays and Sydney CBD* (Sydney Metro, 2020a) included a station in Pyrmont as a strategic station option to be further investigated. This followed earlier community and stakeholder feedback in 2019 which showed strong support for more public transport options in the area, support for increased development density around public transport, and support for the opportunities a metro station could bring to Pyrmont in terms of urban growth and renewal, employment growth and tourism.

The strategic station option analysis for Pyrmont Station considered a number of factors including:

- Customer outcomes and transport – This considered how many station entries would be possible in the configuration and the distance to key attractions (including the current Sydney Fish Market site, Pyrmont Bridge and Darling Harbour) and commercial activities in the catchment, to maximise customer convenience
- Additional tunnel length – Station options that were further away from the tunnel alignment would increase the length of tunnel and, hence, impact on the comparative cost
- Deliverability and value – This includes consideration of risks such as constructability, below ground constraints (including existing basements, heritage constraints in the area, potential land requirements and cost)
- Alignment with key government priorities – This includes strategic alignment to land use and planning frameworks
- Alignment with project objectives – This includes support for integration with the transport network alignment and value for money.

The subsequent evaluation of this strategic option confirmed that the inclusion of Pyrmont Station would support the vision for Pyrmont as the western gateway to the Sydney CBD, forming a continuous innovation corridor between The Bays and Eveleigh. This would also support the Department of Planning, Industry and Environment's *Pyrmont Peninsula Place Strategy* (2020a) that positions Pyrmont as an attractor for global investment, driven by connectivity to the Sydney CBD. The evaluation also found a station at Pyrmont would:

- Provide good strong transport customer outcomes, with station entries located close to key attractions
- Provide an interchange with other public transport modes including bus, light rail and ferry networks
- No significant impacts to overall journey times between Parramatta and Sydney CBD
- Have no significant foreseeable constructability risks
- Provide value for money.

On 11 December 2020, the NSW Government announced that a new metro railway station would be built at Pyrmont as part of Sydney Metro West.

2.2.2 Station location options

During the development of preferred station locations, a range of factors have been considered, including:

- Orientation of station buildings and associated infrastructure to provide effective and efficient access for customers and integration with surrounding land uses
- Constructability
- Minimising impact on heritage and environmental aspects
- Integration with other modes of public transport
- Potential opportunities for future integrated station and/or precinct development above or adjacent to the station and how this is considered in design.

Pyrmont Station

With the announcement of a new metro station at Pyrmont as part of Sydney Metro West, an analysis of a preferred station location was carried out. Potential station options along the Pyrmont Peninsula were considered to identify the optimal location for a metro station.

Station options in the northern and southern parts of the Pyrmont Peninsula were not preferred due to the additional tunnel length required to access those locations and the additional walking distances to Pyrmont Bridge and Darling Harbour. A northern site would also involve substantial walking distances to both the current Sydney Fish Market site and the approved new Sydney Fish Market site on Bridge Road at Glebe.

Station options in the eastern and western parts of the Pyrmont Peninsula were not preferred as they would not provide convenient access to both Pyrmont Bridge and Darling Harbour, and the New Sydney Fish Market site. A station option in the western part of the Pyrmont Peninsula would also be relatively close to The Bays Station which would not maximise the potential customer catchment and, as such, was not preferred.

The station location options analysis found that a station location in the central part of the Pyrmont Peninsula, along Pyrmont Bridge Road, is preferred as it would:

- Provide good transport customer outcomes, with one station entry located close to Pyrmont Bridge and Darling Harbour with access to the Sydney CBD, and another station entrance providing access to the residential areas of Pyrmont and the New Sydney Fish Market site
- Provide access to restaurants, retail, entertainment precincts, including The Star Sydney, the International Convention Centre Sydney, the New Sydney Fish Market, and Darling Harbour waterfront in the vicinity
- Provide an effective interchange including with the existing Sydney Light Rail (L1 Dulwich Hill Line) stop at Pyrmont Bay
- Avoid listed heritage items and minimise impacts on heritage conservation areas
- Have no significant foreseeable constructability risks
- Provide good value for money.

Sydney CBD metro station

The *Sydney Metro West Environmental Impact Statement – Westmead to The Bays and Sydney CBD* (Sydney Metro, 2020a) noted that the preferred location for a Sydney CBD Station was being investigated. It detailed that the metro station would enable interchange with existing public transport networks, including Sydney Metro City & Southwest, the existing Sydney Trains suburban rail network, the Sydney Light Rail (L2 Randwick Line and L3 Kingsford Line) and bus networks.

The station location options analysis for the Sydney CBD metro station considered a number of factors including:

- Meeting customer needs – Key considerations for Sydney CBD customers has been identified as:
  - Connectivity within the Sydney CBD whereby new services would be integrated with existing transport
  - Multiple entry points to provide increased access and flexibility
  - Maintaining perceived safety through the Sydney CBD
  - Overcoming overcrowding at other Sydney CBD stations
- Geology – The existing geotechnical conditions along the tunnel alignment and station locations can impact on construction methodologies. A detailed analysis of geotechnical conditions was carried out during the options analysis at selected locations to ensure the preferred site would be suitable for construction
- Engineering – Given the lack of available space within the Sydney CBD, the metro station would need to be of mined construction, rather than a cut and cover construction. The ground below the CBD is comparatively congested with existing infrastructure and the underground station location and alignment of the metro rail tunnels would need to navigate through these.

Five Sydney CBD station location options were shortlisted as described below and shown in Figure 2-1:

- Circular Quay – Located at the northern end of the Sydney CBD, this location option is within a mixed use area with various commercial, transport, cultural and tourist uses. Customers serviced by this location would include city workers, shoppers and people attending events. There is a direct connection to the existing Sydney Trains suburban rail network. The harbourside location limits the catchment area for this station option location
- Hunter Street – Centred on Hunter Street in the northern part of the Sydney CBD, the primary land use at the station option location is commercial. Customers serviced by this location would be primarily city workers. There is a direct connection to the existing Sydney Trains suburban rail network (Wynyard and Martin Place), Sydney Metro City & Southwest (Martin Place) and light rail Wynyard stop along George Street
- Martin Place – Centred on Martin Place in the northern part of the Sydney CBD, the primary land uses at this station option location are commercial and retail. Customers serviced by this location would include city workers and shoppers. There is a direct connection to the existing Sydney Trains suburban rail network (Martin Place), Sydney Metro City & Southwest (Martin Place) and light rail Wynyard stop along George Street
- Elizabeth Street – Centred on Elizabeth Street near Park Street in the central part of the Sydney CBD, primary land uses at this station option location are commercial and retail. Customers serviced by this location would include city workers, shoppers and people attending events. There is a direct connection to the existing Sydney Trains suburban rail network (Town Hall), Sydney Metro City & Southwest (Pitt Street) and light rail (QVB and Town Hall stops)
- Museum – Centred on Elizabeth Street near Liverpool Street in the southern part of the Sydney CBD, the primary land uses at and near this station option location are commercial, retail, residential and event venues (for example Capitol Theatre and venues along nearby Oxford Street). Customers serviced by this location would include city workers, residents, shoppers and people attending events. There is a direct connection to the existing Sydney Trains suburban rail network (Museum), Sydney Metro City & Southwest (Pitt Street) and light rail (George Street).

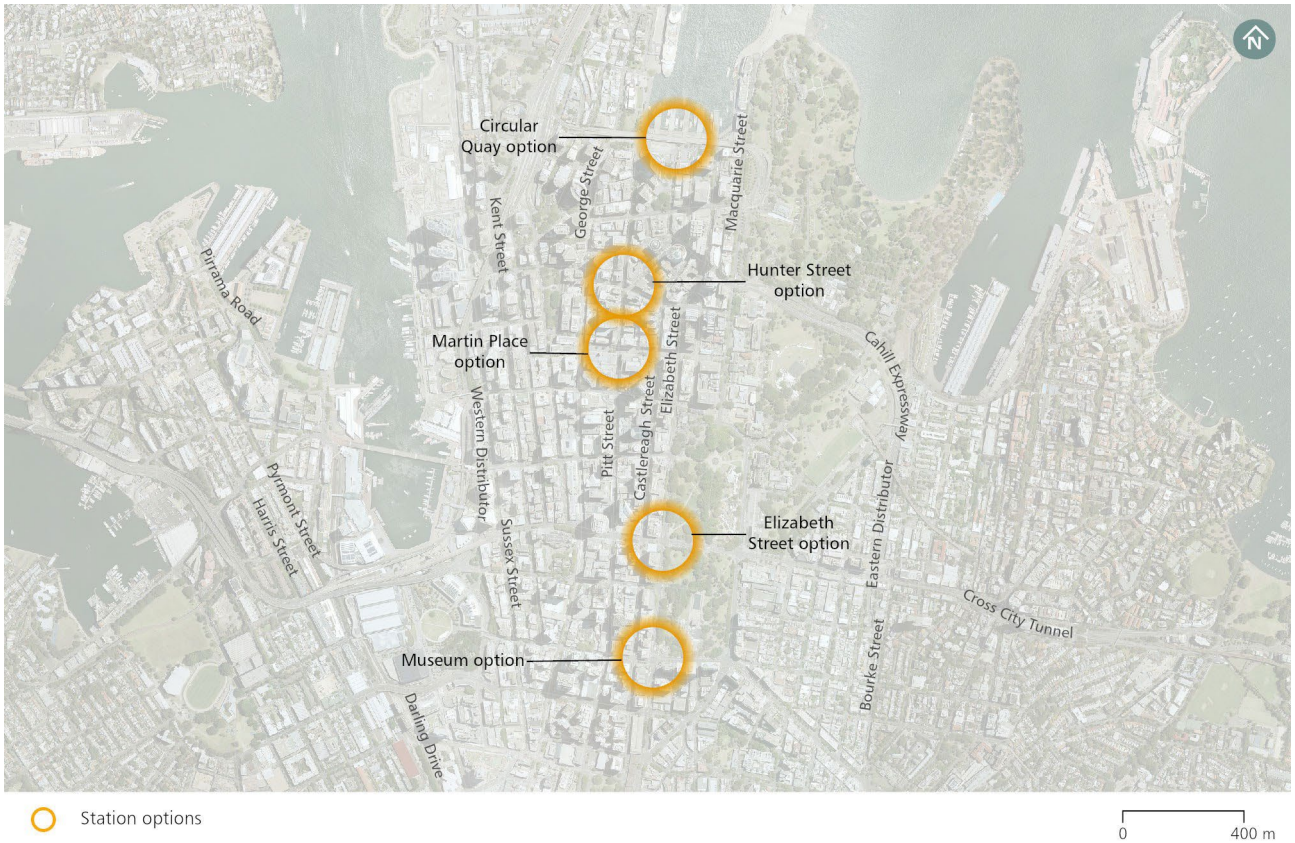

Figure 2-1 Short-listed Sydney CBD station location options

Detailed assessment of shortlisted stations was carried out through assessment against the following two evaluation criteria:

- Customer benefits which considers journey time, personal safety and security, connectivity to other modes, access for all and special events management
- Deliverability and value which includes alignment, site conditions, constructability, community impacts, heritage, flora and fauna, existing transport network impacts, safety and reliability and cost.

The performance of each of the shortlisted station options was assessed in detail against the categories within the Sydney Metro West objectives and scored as 'strong alignment' (green), 'some or neutral alignment' (orange) or 'no or negative alignment' (red). Mixed colours illustrate a mid-point of the main rating categories. The results are summarised at the objective level in Table 2-1 and discussed further below.

Table 2-1 Evaluation of shortlisted station locations

Location	Customer benefits	Deliverability and value
Circular Quay		
Hunter Street		
Martin Place		
Elizabeth Street		
Museum		

The detailed assessment of station locations in the Sydney CBD found:

- Several Sydney CBD station options are likely to present more challenges with respect to constructability, operations and/or functionality. These include station options at Martin Place, Elizabeth Street and Museum
- Of the Sydney CBD station options, stations at Hunter Street and Circular Quay are considered feasible and generally perform well against the evaluation criteria. However, the Hunter Street station option connects closely with the T1 North Shore & Western Line and the T9 Northern Line at Wynyard, as well as the Sydney Metro City & Southwest and the T4 Eastern Suburbs & Illawarra Line at Martin Place
- The Hunter Street station option was found to be the most favourable, providing a suitable station location in the mid to north of the Sydney CBD which would be critical to the success of the Sydney Metro West project and provide direct access to the commercial core of the Sydney CBD.

Although Elizabeth Street and Museum station locations were not considered further during this station location assessment, these station locations will be further considered as part of a potential future extension to Sydney Metro West (refer to Section 2.2.7).

A Hunter Street station location was identified as the preferred station location option for the following reasons:

- Opportunity to provide a new east-west connection between Martin Place and Wynyard Stations, which would benefit customers by offering a fully accessible high-quality interchange and pedestrian environment
- Location at the heart of Sydney's pre-eminent commercial precinct opportunity to provide east-west connectivity will improve accessibility between economic centres
- High levels of usage with almost 22,000 daily journeys on metro services
- Connection between the highest economic activity areas of the Sydney and Parramatta CBDs with a high-frequency, high-capacity and reliable metro service. A metro station at Hunter Street would support a total catchment of about 8,200 dwellings and about 227,000 jobs within a 10-minute walking catchment of the station
- Additional direct access for Western Sydney customers to the northern Sydney CBD
- Opportunity to relieve crowding at Sydney's busiest stations in the 2036 one-hour AM peak, including Central (about 5,200 movements), Wynyard (about 3,600 movements) and Town Hall (about 2,300 movements) stations
- Opportunity to transfer between the metro services at Hunter Street Station (Sydney CBD) and Sydney Metro City & Southwest at Martin Place Station
- Opportunity for customers to transfer to intermediate transport modes in the Sydney CBD, including the light rail along George Street and bus services.

2.2.3 Station construction sites optimisation

As part of the development of this proposal, station construction sites 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 tunnels and stations.

The key factors that have influenced the construction sites for the stations are summarised in Table 2-2 and each construction site is described in detail in Chapter 5 (Project description). In all cases the station construction sites have been reduced as much as practicable to minimise the need for land acquisition, disruption to local communities and environmental impacts.

Table 2-2 Station construction sites optimisation

Station	Factors influencing station construction sites
Pyrmont Station	• Cavern construction with eastern and western entrance • Construction arrangements to retain access for surrounding businesses • Minimisation of construction and operational impacts on locally significant heritage items including the Pyrmont Heritage Conservation Area • Minimisation of land acquisition of established residential properties • Minimisation of construction impact on the road network including Pyrmont Bridge Road
Hunter Street Station (Sydney CBD)	• Mined double height cavern • Construction site required to accommodate tunnel boring machine extraction • Allowance for protection of the State significant listed heritage item Skinners Family Hotel (corner of George Street and Hunter Street) within the construction site and minimisation of construction impacts on nearby State significant heritage items including the Tank Stream • Construction site required to accommodate spoil extraction from station cavern and turnback cavern / tunnels • Location of existing City & Southwest mined cavern excavation facility

2.2.4 Tunnel alignment

The development of the tunnel alignment between The Bays and the Sydney CBD has involved first considering station location options, with the tunnel alignment connecting stations locations to maximise train speed to minimise journey times. Minor rotation or changes to the station caverns have a flow on impact to the tunnel alignment. Horizontal curves and vertical grades, geology, and the need to avoid underground structures (i.e. major utilities and basements) are also considered in finalising the tunnel alignment.

The tunnel alignment for the proposal has been designed to best achieve these considerations between The Bays and the Sydney CBD.

2.2.5 Tunnel configuration and tunnelling support considerations

Tunnel configuration

The tunnel configuration for the proposal is consistent with that adopted for the major civil construction work between Westmead and The Bays. The *Sydney Metro West Environmental Impact Statement – Westmead to The Bays and Sydney CBD* (Sydney Metro, 2020a) provides an assessment of various tunnel configuration options and concludes that a twin-tube tunnel configuration is the preferred option.

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.

Tunnelling support considerations

Principles influencing the selection of the 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 of about 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, The Bays tunnel launch and support site was nominated as the preferred tunnel boring machine launch and potential retrieval site while the Hunter Street Station (Sydney CBD) construction sites were identified as the preferred location for retrieval of the tunnel boring machines. Use of these sites would optimise the tunnelling strategy, with retrieval locations at either end, and with an overall tunnelling distance of about three kilometres. Further construction planning would determine the retrieval location of the tunnel boring machines.

The Bays Station construction site is being established under the major civil construction work between Westmead and The Bays (Stage 1 of the planning approval process). Tunnelling to the west will commence from this location and is anticipated to be vacated in the first quarter of 2023. As such, the availability of this land to continue to support a large tunnel support site and the potential for barge access makes The Bays an optimal location for tunnelling launch and support activities for this proposal. Despite several complex interfaces at the approved construction site at The Bays (other Sydney Metro West tunnelling operations, a utilities corridor, State listed heritage items, other industrial operations and port activities) this remains the preferred site for launching tunnel boring machines to the east.

The Hunter Street Station (Sydney CBD) construction sites were identified as adequate to allow the tunnel boring machines to be pulled into the mined station cavern and disassembled for removal through the eastern shaft. An option to retrieve elements of the tunnel boring machine back at The Bays has also been considered and retained as an option.

2.2.6 Spoil transport

All tunnelling spoil would be removed from The Bays tunnel launch and support site. The removal of tunnelling spoil from The Bays minimises impacts on Pyrmont and the Sydney CBD surrounding road network. Station excavation spoil would be retrieved and removed directly from the Pyrmont and Hunter Street (Sydney CBD) construction sites via the road network.

The *Sydney Metro West Environmental Impact Statement – Westmead to The Bays and Sydney CBD* (Sydney Metro, 2020a) provides an assessment of road, rail and barge/shipping options for the transport of spoil from construction sites.

The assessment identified road transport as the primary transport method given the proximity of construction sites to the motorway and arterial road network.

Rail transport was not considered a viable option due to the need for road transport from the spoil generation site to train loading facilities, and/or the need for shared use of the suburban and/or light rail networks, and the substantial track work and signalling upgrades required.

Barge transport of spoil for regional re-use opportunities or offshore disposal was identified as potentially feasible, subject to further investigations and/or approvals, stakeholder engagement including with harbour users and the agreement of NSW Ports and/or Port of Newcastle and relevant local councils. While the transport of spoil via trucks, as described in the *Sydney Metro West Environmental Impact Statement – Westmead to The Bays and Sydney CBD* (Sydney Metro, 2020a), remains the primary method of spoil transport for Stage 1 of the planning approval process, the *Sydney Metro West Submissions Report – Westmead to The Bays and Sydney CBD* (Sydney Metro, 2020b) provided further assessment of the potential use of barges to transport spoil from The Bays Station construction site. Consideration of barge transport options and reuse opportunities for spoil is continuing as part of construction planning of this proposal.

2.2.7 Potential future extensions of Sydney Metro West

The design development process for this proposal has considered potential future extensions of the Sydney Metro West line towards the south-east. Therefore, this proposal includes a stub tunnel at the end of the proposed turnback, to the east of the proposed Hunter Street Station (Sydney CBD). The stub tunnel alignment has been designed with consideration of the criteria discussed within Section 2.2.4, including horizontal curves and vertical grades, geology, and the need to avoid underground structures, to safeguard any future potential extensions towards the south-east.