

5 Project development and alternatives

This chapter outlines the project development process, examines possible alternatives to a CBD Metro and explains the design decisions that have led to the formulation of the project that is the subject of this Environmental Assessment.

The Director-General's requirements

Project justification – identify alternatives to the preferred project considered (including alternatives to the project itself, the alignment, station, stabling and maintenance facilities, and ancillary facility location options).

5.1 Project development history

5.1.1 Government initiatives

Addressing the transport demands of a 24/7 global city like Sydney is complex and requires a combination of infrastructure and non-infrastructure solutions across all transport modes. The NSW Government is addressing these public transport demands through an integrated package of initiatives.

In the short term, government strategies include the Rail Clearways program, recent completion of the Epping to Chatswood Rail Line, development of the strategic bus corridor network, implementation of the CBD Bus Strategy, introduction of high frequency, high capacity Metrobus routes, and the rollout of new buses and trains.

To address longer term transport demands and further enhance the coordinated management and delivery of services across the network, the government is developing a transport blueprint for NSW that integrates urban growth and transport delivery. A key component of the transport blueprint is a metro network for Sydney to realise the objectives of the government's *Metropolitan Strategy*. The metro network would complement heavy rail, bus and other mode networks.

A metro network was first identified in the 2006 *Urban Transport Statement* (NSW Government 2006a), which recognised that metro would provide the key benefit of operational separation from existing road and rail networks as well as modern rolling stock and train control systems to enhance reliability and facilitate the rapid loading and unloading of passengers.

The original 'Sydney Link' proposal of March 2008 envisaged a North West Metro extending from the Sydney CBD via the Victoria Road corridor to Epping and beyond to Rouse Hill. However, after a review of available funding, the focus shifted to building the first stage of the metro network, between Central Station and Rozelle – the CBD Metro.

In October 2008, the NSW Government announced the proposed CBD Metro, and made a funding commitment to it in its November mini-budget and 2009-10 Budget. The government's commitment acknowledged the need to lay the foundations of a broader metro network for Sydney and recognised the superior characteristics of the metro product when compared with other alternatives. The CBD Metro marks the first critical component in the development of a broader metro network.



In June 2009, the NSW Government announced further investment in a metro network for Sydney, including 11 proposed stations and a corridor alignment for the first extension of the CBD Metro – the West Metro between Westmead, Parramatta and the city.

5.1.2 Why metro?

CBD Metro is the first stage in the development of a metro network for Sydney, which will underpin the transformation of Sydney's transport system into an integrated whole, combining complementary metro, heavy rail, bus and other mode networks, fulfilling clearly defined roles and supporting Sydney's economic growth.

The first line of this wider metro network (Metro Line 1) comprises the CBD Metro extended west from Central to Parramatta / Westmead, and north-west from Rozelle towards the Macquarie Park area. Metro Line 1 is designed to:

- Significantly boost capacity in two of the busiest and most congested corridors in Sydney.
- Relieve congestion, particularly on the CityRail lines and stations in the CBD, as well in the Main Western corridor and on the lower North Shore.
- Enhance access to, and support Parramatta as Sydney's second CBD.
- Stimulate urban renewal in the inner west and north-west.

Alternatives to metro in these corridors cannot deliver the same capacity, land use and transport benefits because:

- The road network in these corridors is already at capacity for much of the day and the significant investment required to achieve comparable levels of service for commuters would be contrary to the government's land use, environmental and sustainability objectives.
- Buses are already operating at or beyond capacity in key sections of these corridors. Even with significant investment in infrastructure to boost capacity and improve travel times and reliability, buses would be unable to achieve the same network benefits as metro.
- Light rail, although more efficient than buses in moving larger numbers of people, would require a high level of investment approaching that of metro, but without providing comparable capacity or travel-time benefits. Light rail largely serves different markets to metro rail and would be unable to meet the wider objectives set for the metro network.
- Heavy rail already operates partly in these corridors (Epping-Chatswood, North Shore and Western lines), but is constrained by the rolling stock, signalling and mixed service style of operation that CityRail is required to operate in what is a highly congested corridor to and through the Sydney CBD.

Another significant benefit of metro is that by providing a new, operationally independent, fast, frequent and quality mass transit system, starting with these two congested corridors, CityRail would receive the 'breathing space' needed to allow a reconfiguration and refocussing of the heavy rail network to improve sectorisation (i.e. 'untangling' the network), and enhance system efficiency.

5.1.3 Overview of planning for the CBD Metro

The announced route for the CBD Metro was formulated to capture the key CBD and Inner West locations of Central, Town Hall, Martin Place, Barangaroo-Wynyard, Pyrmont, White Bay and Rozelle. It was also aligned to facilitate future extensions, including to the west from Central and the north-west from Rozelle. The announced route formed the basis for more detailed investigations and design development and the formulation of a preliminary construction methodology for the project.

The next phase in project development involved the consideration of options at each station location, the definition of an indicative alignment within the corridor and the nomination of locations for other facilities including those for stabling, maintenance and network operation. The product of this phase was the preliminary design included in the Preliminary Environmental Assessment (PEA), lodged with the Department of Planning as part of the Project Application in February 2009.

As foreshadowed in the PEA, further investigations have resulted in a number of refinements to the PEA corridor, the alignment, station locations and layouts, construction sites and other project elements.

Alternatives to the CBD Metro are considered in section 5.2. Options within the project, and the factors underpinning design decisions, are detailed in sections 5.3 to 5.6.

5.2 Alternatives to the CBD Metro

The CBD Metro would be the backbone and the first step of a Sydney-wide metro network, with a planned extension to the west and potential future extensions to the north-west, south-east and north-east. As part of the assessment process, the government considered the merits of a range of potential alternatives to the CBD Metro. These alternatives are presented below. The alternatives are:

- The 'no-build' case.
- Road network improvements.
- Enhancing existing public transport networks.
- Demand management measures.

5.2.1 The 'no-build' (or 'base case') alternative

The no-build case (or base case) is intended to reflect the transport network in the absence of the CBD Metro. It is not a 'do nothing' scenario but instead captures the public and private transport infrastructure and service improvements that will be implemented irrespective of the CBD Metro.

The *State Infrastructure Strategy* details a 10-year program of investment, including \$3.2 billion capital expenditure on transport, half of which is being spent on public transport.

Continuation of current policies and committed projects as outlined in the *State Infrastructure Strategy* includes implementation of:

- The Inner West Busway (Victoria Road Upgrade).
- Bus fleet expansion.
- The CBD Bus Strategy.



- The Strategic Bus Corridor program.
- Metrobus routes.
- The Public Transport Information and Priority System (PTIPS).

It also includes existing RailCorp investment plans such as the Clearways Program and RTA planned road capacity improvements.

This investment in transport provides short-term relief to the capacity constraints on the existing transport network in and around the Sydney CBD. However, it is likely that the additional capacity this investment provides will be substantially consumed by forecast growth over the next 10 years. There is a limit to the capacity that can be derived from the existing transport network without major augmentation from an additional transport mode.

The challenge is to harness and shape the planned growth to contribute positively to Sydney's amenity and economy, and support the government's directions and priorities as set out in the *Metropolitan Strategy* and the 2006 *State Plan*. The best model is to encourage a significant proportion of the population and employment growth into corridors and centres supported by new, high quality transport. Otherwise, development will be scattered across the metropolitan area, with much of the new housing and employment either dislocated from high quality transport or concentrated around corridors with significant capacity issues.

Compared with the CBD Metro as the first step towards a wider metro network for Sydney, the base case alternative would:

- Create unsustainable pressure on existing services and a greater dependency on cars.
- Not provide the long-term capacity requirements for the projected population and employment growth.
- Not soundly link land use and transport planning to provide improved urban environments and sustainable outcomes.
- Not support the expansion of Sydney's CBD into Barangaroo and beyond into White Bay.
- Not enable capacity and service enhancements to Sydney's CityRail suburban network.
- Not enable public transport mode split targets in the *State Plan* to be met or maintained.

5.2.2 Road network improvements

The City of Sydney has the highest level of public transport use of any Australian capital city. With Sydney's public transport already operating at or near capacity in peak periods, future growth in CBD employment without significant public transport capacity improvements would mean accommodating for further increases in car use, either by catering for additional car trips or increased car occupancy.

Provision of further road space for private commuter trips as an alternative to the CBD Metro is not considered a sustainable response to Sydney's transport needs and would be inconsistent with NSW Government policy as expressed in key documents such as the *State Plan*, the *Metropolitan Strategy*, the *NSW Greenhouse Plan*, and *Action for Air*. It would also run counter to the initiatives promoted within the government's CBD Bus Strategy, which aims to increase bus priority and improve the efficient movement of buses to and through the CBD.

More specifically, the Sydney Harbour Bridge and Victoria Road/Anzac Bridge are two principal gateways to the CBD, and already suffer from extended peak period demand, as do many other major

arterials leading to the CBD. These roads would need to be significantly enhanced if required to cater for any increased demand.

Increased parking spaces would also be needed in the CBD, while vehicle priority at intersections would need to favour vehicle movements at the expense of pedestrian priority. Buses would also suffer from increased competition for road space, with further pressure on the provision of bus priority lanes, while amenity in the CBD would suffer directly from increased noise and air pollution.

5.2.3 Enhancing existing public transport networks

CityRail service and network enhancements

The government considered enhancements to the CityRail network as a possible alternative to CBD Metro. These include improving CityRail's operations to embrace metro-style characteristics, and extending the system in the CBD and Inner West.

To understand why these alternatives are inferior to metro, it is necessary to understand the CityRail network.

CityRail accommodates three types of service in Sydney (long-distance intercity services, outer suburban express services and short-haul all-stops local suburban services) which result in a mix of stopping patterns, with both fast and slower services sharing a limited number of inner-suburban tracks. Combined with double-deck rolling stock (which is not suited to rapid loading and unloading), this significantly reduces the ability of many suburban corridors to maximise the high number of services (and passengers) that can be delivered into the CBD corridor stations. It also limits the ability of CityRail to accommodate future growth in the outer regions of Greater Sydney, even though it is these longer distance markets that are most suited to the current CityRail style of operation.

The current configuration of double-deck rolling stock used on the CityRail network, with two doors per carriage, relatively small vestibules and narrow stairs, restricts passenger loading and unloading at already crowded city stations, leading to extended dwell times at busy stations and, with the acceleration and braking characteristics of the trains, effectively limits the line capacity to 20 trains per hour.

Enhancing the heavy rail network as an alternative to the CBD Metro would require a change to a metro-like service, involving simplified (or no) timetables, a move towards single-deck rolling stock with more doors per carriage and a higher proportion of standing passengers, together with upgraded signalling, power supply and train protection system. This would enable a higher frequency and higher passenger capacity service. Such enhancements could enable gradual efficiency improvements in the operation of the system on a line-by-line basis and ensure the most effective use of the existing system, thereby complementing a future metro network.

For rail network enhancements to represent a genuine alternative to the CBD Metro, coverage would also need to be extended to cover the same travel catchments such as Pymont, White Bay and Rozelle and a gateway provided to the north-west sector. Network capacity improvements, including a new track pair through the CBD, would also be needed.

These measures are likely to require investment far exceeding that required for the CBD Metro, but without the advantages that come from enabling a new functionally separate and integrated transport mode.



In short, the CBD Metro would have the following advantages over the alternative of enhancing the heavy rail network:

- CBD Metro would service inner-suburban demand and new suburban corridors, and relieve CityRail of some of its shorter distance suburban and CBD traffic. In so doing, it would create scope for the configuration of heavy rail services to increasingly focus on addressing longer-distance suburban trip demand as occurs in other international cities.
- CBD Metro would extend the rail distribution system within the CBD.
- By freeing up capacity on the CityRail network, CBD Metro would create the opportunity to reconfigure CityRail services, with the potential to operate additional services from the South and Northern Lines. In this way, the two railway modes would complement each other.

Bus service and network enhancements

The NSW Government is implementing a range of measures to enhance bus services as part of its *CBD Bus Strategy*. The Strategy is directed at addressing short-term capacity constraints and improving access for buses into and through the CBD.

An alternative to the CBD Metro would involve significant investment in bus services, which would involve many more buses on Sydney streets. However, these would provide only a partial solution to Sydney's longer term transport capacity and congestion issues, and would not provide the enabling infrastructure for a Sydney-wide metro network.

While buses will continue to form an integral part of Sydney's public transport system, the alternative of enhancing the bus network and services is less favourable than the CBD Metro because:

- Bus options alone would not be able to address passenger demand in the medium to long term. The number of buses required to provide a commensurate level of passenger capacity would potentially create major issues for the accommodation of layover and terminal space in the CBD.
- Increased volumes of buses in the Sydney CBD would significantly reduce amenity, particularly for pedestrians, through increased noise, exhaust emissions, congestion and the use of road and kerb space for bus stops.
- Buses operating on congested road corridors are currently subject to delays and unreliability associated with sharing road space with other traffic and it is very difficult, if not impractical, to give full priority (as with a bus rapid-transit type system) without complete grade separation and/or extensive land acquisition for road widening. A tunnel for use by buses over a distance such as that from the CBD to Rozelle would be impractical due to requirements for ventilation and the cost relative to the number of passengers that could be carried by a metro.
- Bus systems – even those operating within a dedicated right-of-way – are not as efficient at moving the very large numbers of people that can be carried on a rail-based metro-style operation.
- As with the heavy rail alternative (above), a bus rapid transit (BRT) strategy would not enable wider network benefits; it would not facilitate network benefits with regard to optimisation of the CityRail network; and it would not address the need for a new and independent transport product that has the potential to be expanded across the entire metropolitan area.
- Bus enhancement options using the existing road network would be constrained by congestion on the road network, and travel times and reliability would be inferior to the CBD Metro.

Extension of the light rail line

To be an alternative to CBD Metro, light rail would need to link Rozelle to the City, including serving Barangaroo, and, most importantly, in terms of its strategic contribution to Sydney's transport system, enable capacity enhancements to Sydney's rail network, as well as facilitate future public transport corridor development. While light rail could be considered as an alternative, it would be inferior to the CBD Metro for the following reasons:

- Light rail generally has a lower carrying capacity compared with metro and would be unable to service the demand for travel within the CBD centre.
- Light rail would be unable to fully address the demand generated by the future employment function of Barangaroo, with office space for 22,000 workers planned.
- Light rail would not address network and station congestion on the existing rail network.
- Light rail would take only around 20 per cent of the buses off the street, whereas the CBD Metro is estimated to reduce buses using Anzac Bridge to gain access to Sydney CBD in the AM peak hour by about 30 per cent and buses on George Street north of Druiitt Street in the AM peak by around 45 per cent.
- There would be a number of difficulties with servicing Rozelle with light rail. Given the lack of space in the Victoria Road corridor, an exclusive corridor separate from Victoria Road would be required to give the required speed and reliability enjoyed by metro. In turn, this would require substantial investment and involve major land acquisition, leading to significant associated community impacts. As with a segregated bus alternative, it would offer a less cost-effective solution than a metro. An option that utilises Victoria Road would have substantial traffic flow impacts and would be unlikely to achieve acceptable running speeds.
- Extending the existing light rail from Rozelle Bay would not be a practical alternative to the CBD Metro due to the circuitous route to the CBD and the uncompetitive travel times, which would be longer than current bus services.

Similarly, there would be difficulties in extending the existing light rail line from Central through the CBD, including:

- High vehicular traffic levels within the CBD and lack of on-street space for tracks.
- High pedestrian traffic levels within the CBD and the 'scramble' system of crossings on main streets such as George Street, which stops traffic in all directions and slows vehicular movement.
- The width of streets in relation to the dimensions of the current light rail system (i.e. the streets are narrower than would be optimal).
- The lack of space for on-street infrastructure, such as catenary wires and supports.
- The lack of space on pavements for light rail stops to be introduced, particularly if these stops are to be accessible for people needing ramps.
- The absence of any one suitable street, which extends from Central to Circular Quay, with each street having specific challenges and obstacles along its length.

Overall, light rail as an alternative to the CBD Metro would provide an indirect route and slower travel times. Together with its relatively high costs, lower capacity and significant difficulties as outlined above, light rail would make a less attractive option compared with metro.



5.2.4 Demand management measures

Travel demand and congestion management is concerned with managing the need to travel, the time at which it occurs and the mode used in order to increase the efficiency of existing transport networks and allow more flexible operation. These measures may include:

- Differential pricing (sometimes called 'congestion pricing') and amended fare structures. For example, a London-style congestion-pricing scheme has been suggested for inner Sydney to manage demand in the CBD, based around a 'toll-ring'. Tolloed access would restrict car access to the CBD by charging vehicles to enter a designated CBD toll-ring. The revenue generated could be used to finance the public transport capacity enhancements necessary to accommodate the increased demand. Another example is the introduction of variable time-of-day tolls on the Harbour crossings into the CBD.
- Timed tickets. These include offering cheaper fares in off-peak periods to reduce congestion in the peaks.
- Travel planning and information campaigns. These include public education campaigns to attract people to public transport.

However, demand management strategies would be inferior to the CBD Metro for the following reasons:

- Congestion pricing would focus on the Sydney CBD, and its impact on overall network performance would be limited. Also, if adequate revenue were to be raised through tolls, then there would still need to be a sufficient volume of vehicles entering the CBD. It could result in either a mode shift from cars to public transport or potentially initiate a demand switch to destinations other than Sydney CBD. The additional cost imposed on commercial vehicles that provide services and stock retail shops could potentially increase the price of goods and services in the CBD.
- Restricting parking availability and increasing parking charges is a limited strategy on its own. The government's ability to directly influence the price of parking in off-street parking stations in the CBD is currently limited as the stations are largely under private control. The CBD currently provides limited metered on-street parking, and a mixture of short-stay and discounted long-day off-street parking which is subject to the government's Parking Space Levy, used to fund public transport projects such as bus interchanges and commuter car parks at suburban rail stations.
- In order to be effective, demand management measures need to apply across the transport system in a coordinated way to send consistent signals to transport "consumers" about ways to optimise their travel while minimising their costs. In this way they complement public transport projects rather than representing a valid stand-alone alternative. Conversely, public transport infrastructure and services need to be in place to cope with the anticipated level and timing of demand, so that price-driven consumer behaviour can be reinforced by a good level of service which attracts people onto public transport.

More specifically, demand management measures alone would not meet a number of the key objectives for the project including:

- To deliver mass transit capacity where it is needed most – in and around the Sydney CBD.
- To facilitate the optimisation of the CityRail network and create a wider range of timetable and investment choices for the existing commuter rail network.
- To solidly link land use planning with transport planning, particularly with regard to the planned major new development at Barangaroo, and possible future development at the Bays Precinct.

Experience has shown that demand management can be an effective tool in shaping travel patterns, but these policies require careful coordination and sustained implementation to deliver long-term results. Effective demand management can help relieve capacity concerns, defer the need for additional infrastructure investment and lead to more efficient use of transport resources.

While demand management options are an important part of any transport strategy, they would not deliver the major capacity gains required on their own. The NSW Government will continue to address travel demand management at the urban and regional level through planning policies including the *Metropolitan Strategy*, *State Plan* and the *Urban Transport Statement*. The focus will be on demand management as a policy measure supporting key public transport initiatives rather than as a stand-alone transport solution.

5.3 Future-proofing the CBD Metro

5.3.1 Design issues

The inherent features of the CBD Metro project enable the potential future extension of the metro and the delivery of other major projects potentially influenced by CBD Metro, including CityRail network improvements.

The process undertaken to develop the Reference Design of the CBD Metro has anticipated the potential form and function of these projects particularly that of an expanded metro or heavy rail network through the Sydney CBD. The aim has been to minimise potential negative consequences or capture opportunities arising from the design of the physical infrastructure being delivered as part of the project.

The design of the CBD Metro has been influenced by the need to:

- Ensure that the CBD Metro does not preclude additional metro and heavy rail alignments through the Sydney CBD, which may be required to augment the existing CityRail network and provide additional future metro rail lines.
- Provide for five-car rolling stock that can be upgraded to six-cars as patronage increases.
- Design CBD Metro stations to allow for:
 - Future metro and heavy rail interchange.
 - Potential future pedestrian connections and breakthroughs.
 - Delivery of the City of Sydney Council's aspirations for a future Town Hall Square.
- Design and build the White Bay site to allow for a station to be developed at a future date, without compromising metro rail operations.
- Ensure the stabling and maintenance depot for the CBD Metro:
 - Can be expanded to provide stabling facilities for rolling stock required for a possible future extension of the line to the west and maintenance facilities for possible future extensions to the west and north-west.
 - Does not preclude extension of the light rail to Dulwich Hill by safeguarding the land required for a future light rail stabling facility at Lilyfield (east of Catherine Street bridge).



- Provide for future metro-to-metro interchange at Central, Martin Place and Barangaroo-Wynyard.
- Design and build other infrastructure elements as part of the CBD Metro, such as tunnel stubs at Central and Rozelle, to allow for future extension of the line to the west and north-west.

Ultimately, the primary objective of the project is to provide an enabler for a new, fully integrated but independently operated transport system that would significantly assist in future-proofing the long-term transport needs of Sydney.

5.3.2 Staging of the metro network

There are a number of reasons for the CBD Metro being the first stage in the broader metro network. There are also clear reasons justifying its start/end points at Central and Rozelle.

Why build the CBD Metro first?

With the first metro project intended to function as the foundation of the metro network, it was considered fundamental that it service the CBD with its key employment generators. Proceeding with other arms of the network in advance of the CBD solution would only serve to exacerbate existing transport network congestion issues in the CBD. These issues were outlined in Chapter 4 and include network and station capacity issues. A CBD Metro also provides the greatest flexibility as a network enabler for future metro-to-metro interchange with lines to the north-west, north-east, west and south-east.

Why a start/end point at Central?

Central was selected because:

- Central is the terminus for a number of InterCity rail services from which passengers currently have to transfer to already very crowded CityRail trains in order to reach the heart of the CBD or beyond. CBD Metro would offer a new high capacity link between Central, Town Hall Square, Martin Place and Barangaroo-Wynyard, thereby taking pressure off the existing suburban trains and platforms (especially platforms 16 and 17) and also relieving peak congestion at the existing Town Hall and Wynyard stations by redirecting passengers to CBD Metro.
- By providing a new link between Central and the heart of the CBD, and relieving congestion in the Main Western corridor, the CBD Metro would provide the opportunity to reconfigure CityRail services and potentially increase train paths from the west and the south. The CBD Metro would have an important role in reducing congestion at Central Station by enabling intercity commuters to access the metro network as well as having a choice of using CityRail services.
- A start/end point at Central allows for a future metro extension to the west. Indeed, the West Metro, which is planned to be the first extension of the CBD Metro, could not be provided without the CBD Metro being in place.

Why a start/end point at Rozelle?

Rozelle was selected because:

- It would facilitate future extension along the Victoria Road corridor to the north-west.
- Rozelle is the first significant higher density suburban destination beyond the CBD. The patronage forecasts show Rozelle to have the highest forecast patronage of any non-CBD station.
- Rozelle is at a natural crossroads of key bus routes and therefore has potential as a major bus-metro interchange point. This bus-metro interchange provides the opportunity to reconfigure the bus network and relieve bus congestion on Anzac Bridge and in the CBD.

- The former Rozelle Marshalling Yard was identified as the most suitable site for a future train stabling depot serving CBD Metro. This meant that the CBD Metro needed to extend at least as far as White Bay to give access to the stabling depot. Providing a station at Rozelle was a short extension into a suburban area and hence was seen as providing an economically efficient location.

5.4 Route alternatives

The development of the CBD Metro alignment (vertical and horizontal) has been governed by a number of considerations including the need to:

- Provide for stations to be built at preferred locations (see section 5.5).
- Take account of operational requirements for customer experience and maintenance.
- Minimise impacts on future CBD developments by following road alignments as far as possible.
- Minimise impacts on existing structures and basements.
- Minimise impacts on existing underground infrastructure.
- Utilise the protected Interim Rail Pitt corridor (as described in the infrastructure SEPP) as much as possible.
- Avoid conflict with the protected Interim Rail West corridor (as described in the Infrastructure SEPP) and other underground infrastructure.
- Help manage risks arising from tunnel design issues.

These considerations informed the development of the alignment and the associated corridor presented in the PEA. Following further investigation of the PEA alignment, modifications were proposed at a number of locations.

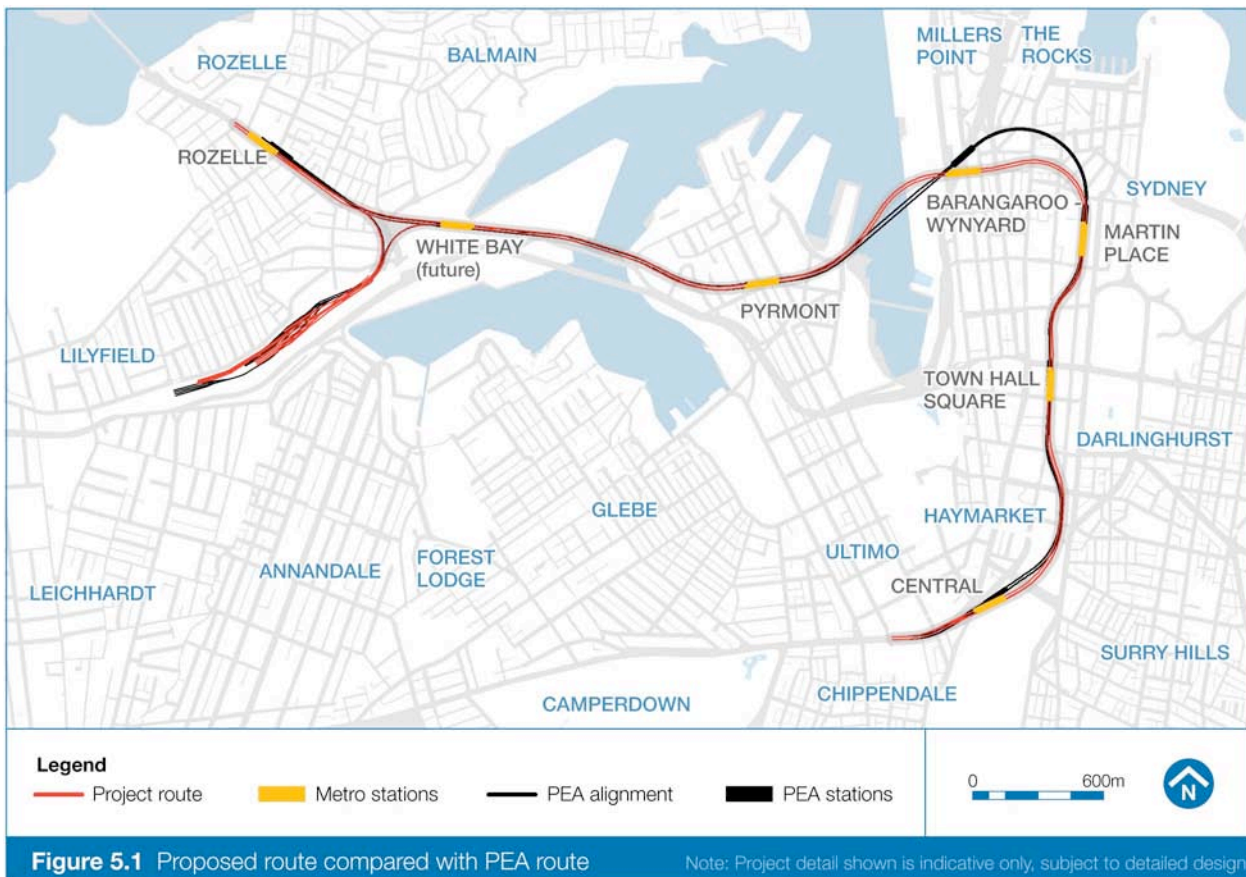
The principal change affecting the entire route was the requirement to lengthen the platform to accommodate six-car rolling stock. Some changes to the vertical alignment were also necessary.

The revised alignment deviates from the corridor identified by the PEA at four locations, as outlined below and in Figure 5.1.

- South of Central Station – with adjustments to the station position, part of the tunnel to the south of the station deviates outside the PEA corridor by about three metres.
- Martin Place to Barangaroo-Wynyard – with the proposed Barangaroo-Wynyard Station being realigned along Margaret Street to achieve better interchange times and avoid key sub-surface constraints, the alignment in this section deviates to the south of the PEA corridor.
- Eastern Darling Harbour – the alignment to the west of the proposed Barangaroo-Wynyard Station is now positioned to the north of the PEA corridor by about 45 metres due to the revised station location (see section 5.5.4) and the need to avoid the deep basement under the KPMG building between Shelley Street and Lime Street.
- Rozelle – with the redesign of the proposed Rozelle Station (see section 5.5.7) the approach tunnels would deviate to the south of the PEA corridor by up to eight metres.

The alignment shown is subject to further development. Changes may occur as new information is obtained during the detailed design and construction phases.





5.5 Station selection and design

The CBD Metro includes new stations at Central, Town Hall Square, Martin Place, Barangaroo-Wynyard, Pyrmont and Rozelle. It also involves the safeguarding of a station at White Bay in recognition of the redevelopment potential of this significant government-owned harbourside location.

The selection of these station locales was governed by a number of considerations, including the need to:

- Service demand in key catchments along the corridor.
- Facilitate interchange with CityRail services and reduce overcrowding at CityRail stations.
- Provide for potential future extensions of the metro network.

The selection of specific locations within each locale was based on servicing the identified catchment, pedestrian flows and connectivity, interchange, environmental constraints, alignment and major engineering and constructability issues.

The station design options presented in the PEA have been the subject of an ongoing design development process and stakeholder/community consultation that has involved the iterative development of design options to respond to particular issues and constraints at each location. The resulting station designs are referred to as the Reference Design and are described in detail in Chapter 6. It is important to note that some station elements, in particular station entrance locations, may change as a result of design development and feedback from the Station Plans (which are concurrently exhibited with this Environmental Assessment).

The issues and options considered at each locale are discussed below.

5.5.1 Central

Why a metro station at Central?

As presented in section 5.3.2, a station at Central is fundamental to achieving effective interchange with the heavy rail network, given that the majority of suburban, inter-city and CountryLink services serve Central and recognising the existing crowding issues at other CityRail stations in the city. The provision of a station at Central provides existing CityRail customers with a choice of rail services through the CBD as well the additional capacity needed to relieve congestion on the CityRail network.

Central is also well positioned to facilitate the expansion of the metro to the west. In addition to its primary interchange function, Central also has independent demand with a significant walk-up catchment. It services the southern CBD precinct, which encompasses specialised retail, cultural and education facilities. Key travel demand generators in this area include the University of Technology, Sydney TAFE and Paddy's Markets. It also supports future development of the wider precinct, including the redevelopment of the Carlton and United Breweries site on Broadway.

A metro station at Central also creates a major opportunity for 'place-making' with the potential for major improvements to the public domain and an enhanced retail function.

Locating the station and station entrances

A number of station locations were considered for the Central precinct including within Belmore Park, under the Central Terminal platforms and two locations on the western side of the existing station complex. These locations are illustrated in Figure 5.2 and the options progression process is summarised in Table 5.1. The preferred location, documented in the PEA, was on the western side of Central Station in the area bounded by Eddy Avenue and Pitt Street (identified as option 'E' within the table).

This location would provide:

- Efficient integration with the existing structure and planning of the existing Central Station buildings.
- Direct and efficient connections, and interchange links, with CityRail services via the Country Link platforms and main concourse hall of Central Station.
- Opportunity for legible entrances on Pitt Street and Eddy Avenue.
- Opportunity for direct and efficient connections to other transport modes such as the light rail and bus interchanges in Railway Square and Eddy Avenue.

Heritage issues associated with the impact on certain elements of the existing station complex were acknowledged and the need for an appropriate design response was considered.

Refining the station location and design

The PEA scheme for Central reflected a number of uncertainties. The PEA was completed without the benefit of complete detailed engineering assessment required to inform major structural and infrastructure matters. At the time it was developed, the constraints associated with the RailCorp Interim Rail West corridor and the Eastern Suburbs CityRail Line had not been assessed in detail. The extent to which the clock tower at Central Station represented a constraint to subsurface works required further engineering investigations. Heritage impacts associated with the proposed cut and cover construction method were an unresolved issue, as was the best method of achieving interchange with CityRail services.

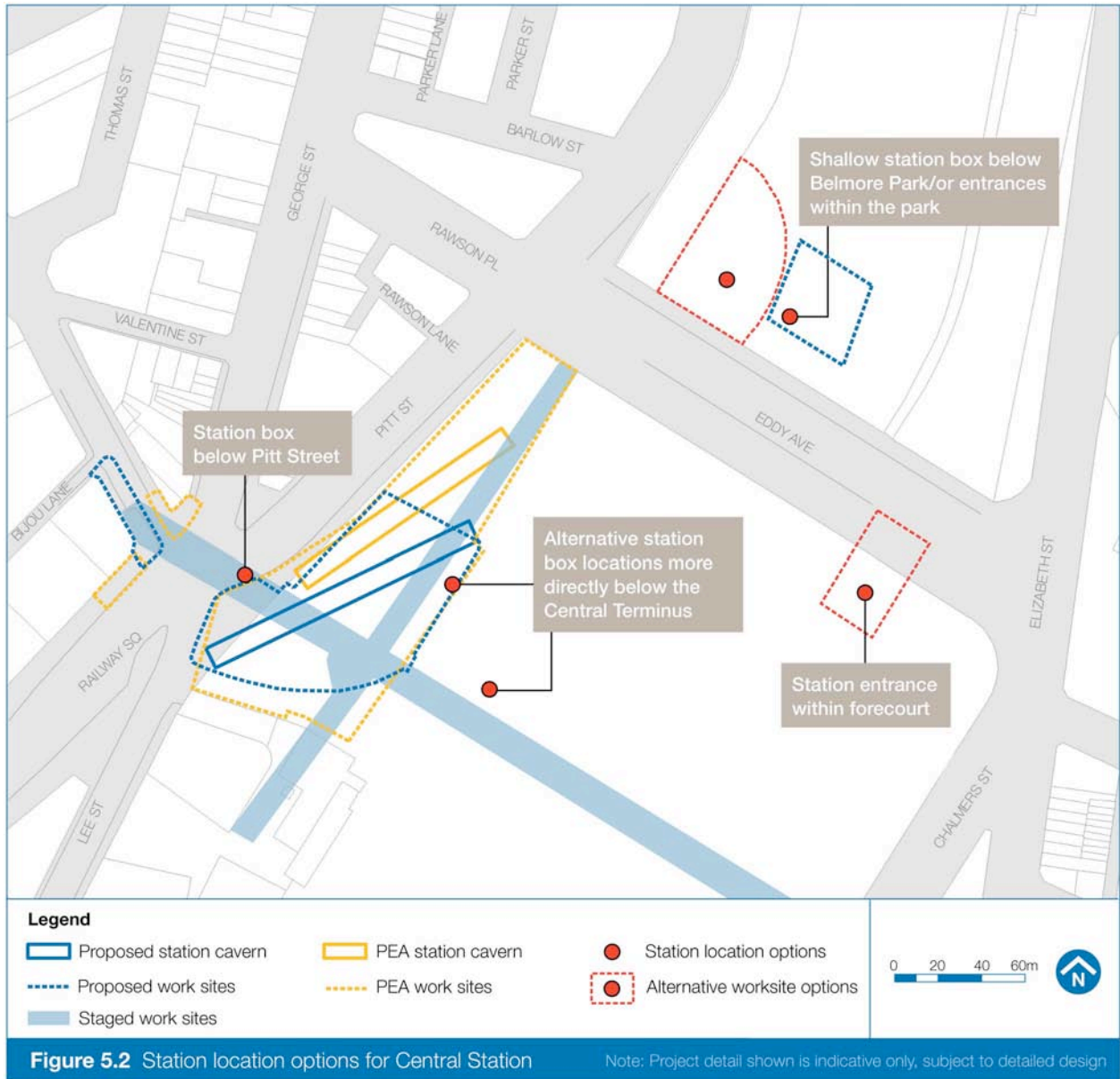
The proposed scheme now responds to these issues. The station cavern is located in much the same position as described in the PEA, but is located deeper to allow the alignment to avoid the Eastern Suburbs CityRail Line and a range of utilities under Hay Street. The construction method now proposed is part cut-and-cover and part cavern construction to address identified heritage issues.



Revised worksites reflect the new station cavern position, entrances and construction methodology. The PEA and currently proposed worksites are also shown in Figure 5.2.

Table 5.1 Progression of station location and design options for Central Station

ID	Description	Key considerations	Key issues
A	The 'PEA' station	Best solution reflecting a number of uncertainties.	Developed without the benefit of a complete detailed engineering assessment to inform major structural and infrastructure matters.
B	Shallow station below clock tower with additional entrance in Belmore Park	Responded to engineering constraints, location of existing and proposed RailCorp corridors, heritage impacts and constructability issues. Provided additional entrance option.	Some constructability issues remained, including cut and cover of Eddy Avenue. Heritage impacts were less, but still significant. Risk of damage to clock tower. New impacts in Belmore Park.
C	Station below Central Terminus	Attempted to better integrate with CityRail services. (Metro entrance within eastern forecourt also examined)	Unable to construct without significant impacts on existing rail operations. Heritage impacts were less, but still significant. Substantially higher cost.
<i>[Further geotechnical and services information resulted in changes to the alignment. Alignment now safeguards existing and proposed RailCorp corridors]</i>			
D	Deep station below clock tower and Belmore Park with additional entrance in Belmore Park	Further response to engineering constraints, heritage impacts and constructability issues. Provided additional entrance option. Improved links to heritage Country Link ticket hall.	Some constructability issues remained, including cut and cover of Eddy Avenue. Heritage impacts less, but still significant, including new impacts on Country Link ticket hall. Risk of damage to clock tower reduced, but still a concern. New impacts in Belmore Park.
E	Proposed – shallow station below Western Forecourt	Further response to engineering constraints and constructability issues. Creates opportunities for most effective pedestrian links, including east-west link to Chalmers Street and connection to Henry Deane Plaza. Significantly less heritage impacts. Reduced impacts during construction (traffic, heritage, pedestrians).	Staged delivery and significant liaison with RailCorp required to achieve ultimate solution.



5.5.2 Town Hall Square

Why a metro station at Town Hall Square?

A metro station at Town Hall Square would provide an alternative station serving the midtown area and interchange with buses, thereby helping to relieve congestion at the existing CityRail Town Hall Station.

Town Hall Square Station would service the mid CBD area between Hyde Park and Darling Harbour including Town Hall, Pitt Street Mall and the Queen Victoria Building. This area is a major shopping destination with that role being reinforced by the recent redevelopments of Westfield Sydney Tower and the Mid City Centre, and the ever-increasing hotel, tourism and theatre presence.

A metro station at this location also presents an opportunity to assist the City of Sydney in achieving its '2030 Vision' for the creation of a Town Hall Square on the site of the current Woolworths building.

Locating the station and station entrances

Two alternative station locations were considered for the Town Hall precinct, one at the intersection of Bathurst and Pitt streets, the other at the intersection of Park and Pitt streets. The differences between the options and the current design are minor because constraints associated with the Cross City Tunnel (CCT) and building basements meant there was little flexibility in the location. Figure 5.3 shows alternative station locations considered along with the currently proposed location.

The progression of station location and design options is summarised in Table 5.2. The preferred location (identified as option 'G' within the table) was identified as the intersection of Park and Pitt streets because it would create better opportunities for integration with the future Town Hall Square and be closer to the main retail zone to the north.

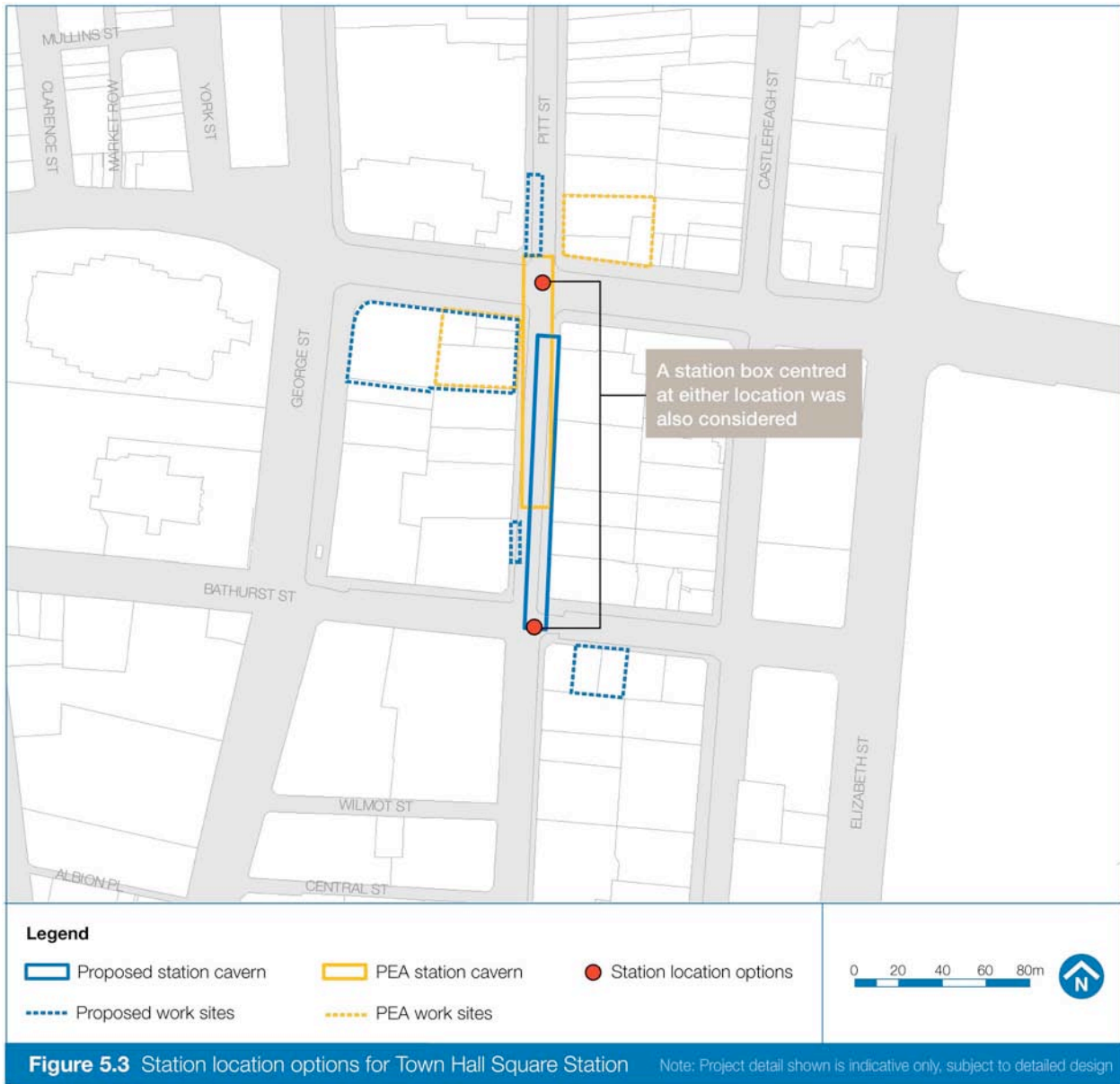
Refining the station location and design

The PEA scheme for Town Hall Square station reflected uncertainties regarding Cross City Tunnel and building basement constraints. In response to these issues and following more detailed geotechnical investigations and basement surveys, the position of the station cavern was moved to the south, below Pitt Street and between Park and Bathurst streets. This in turn resulted in the need for a services building to the south. The revised station position also provided better opportunities for integration with the Town Hall Square vision. Revised worksites reflect the new station cavern position and the need for a services building on Bathurst Street. The PEA station location and currently proposed worksites are shown on Figure 5.3.

Table 5.2 Progression of station location and design options for Town Hall Square Station

ID	Description	Key considerations	Key issues
A	PEA station	Best solution reflecting uncertainties regarding Cross City Tunnel (CCT) and building basement constraints. Two entrances on each side of Park Street.	N/A
B	Station box moved north	Two entrances on each side of Park Street.	Did not respond to uncertainties regarding CCT and building basement constraints.
C	Station box moved south	Two entrances on each side of Park Street.	Did not respond to uncertainties regarding CCT and building basement constraints.
<i>[Confirmation of constraints (particularly deep basements) results in change to alignment. Design to protect CCT also confirmed]</i>			
D	Proposed station cavern with services building required on Bathurst Street	Two entrances on each side of Park Street, however smaller entrance on northern side to reduce property impacts. Responded to uncertainties regarding CCT and building basement constraints.	Inadequate area to construct the station.
<i>[Discussions with City of Sydney Council initiated to explore realisation of Council's vision for a new Town Hall Square]</i>			
E	Improvements to Option D to utilise Woolworths site for construction	Solved constructability issues. Provided a catalyst for development of Council's vision for a new Town Hall Square.	Increased property and construction impacts. Increased cost.
<i>[Continued discussions with City of Sydney Council to explore options that may suit their vision for a new Town Hall Square]</i>			
F	Approximately 12 variations to Option E explored	Various options developed to respond to Council issues and achieve an integrated outcome.	Different property impacts (generally greater than the proposed scheme).
G	Proposed – main entrance on corner of Park and Pitt streets	Two entrances on each side of Park Street, plus link to CityRail's Town Hall Station. Still required services building on Bathurst Street. Smallest land take on area adjacent to the new Town Hall Square.	Significant liaison with City of Sydney Council required to achieve the ultimate solution.





5.5.3 Martin Place

Why a metro station at Martin Place?

Martin Place is at the financial core of Sydney and has the highest density of jobs within the CBD. This, coupled with a number of key attractors including Customs House, the Domain, State Library, Parliament House and Circular Quay, gives this station an important catchment to service.

A metro station at Martin Place would provide an opportunity for interchange with services from the CityRail Eastern Suburbs and Illawarra lines as well as the Eastern Suburbs bus services that use Elizabeth Street. It also provides an option for a metro-to-metro interchange with a future metro line to the south-east.

Locating the station and station entrances

At Martin Place, the station cavern location was generally defined by the requirement for:

- A location under a north-south street to minimise property impacts.
- Proximity to the existing CityRail Martin Place Station to facilitate interchange.
- An alignment that allowed connection to the proposed CBD Metro stations at Town Hall Square and Barangaroo-Wynyard.
- Major underground basements to be avoided and the need to utilise, as far as possible, the protected Metro Pitt Interim Rail corridor.

In the PEA, Martin Place was identified as the best location for a southern station concourse and a number of options were considered for a northern station concourse. These were:

- BNP House between Castlereagh Street and Elizabeth Street.
- BHP building on the corner of Castlereagh Street and Hunter Street.
- Kindersley House on the northern side of Hunter Street.

Figure 5.4 shows options for the northern concourse.

The PEA indicated that the preferred location for a northern concourse was at Kindersley House. Advantages of this location were its size and ability to facilitate access to the northern CBD.

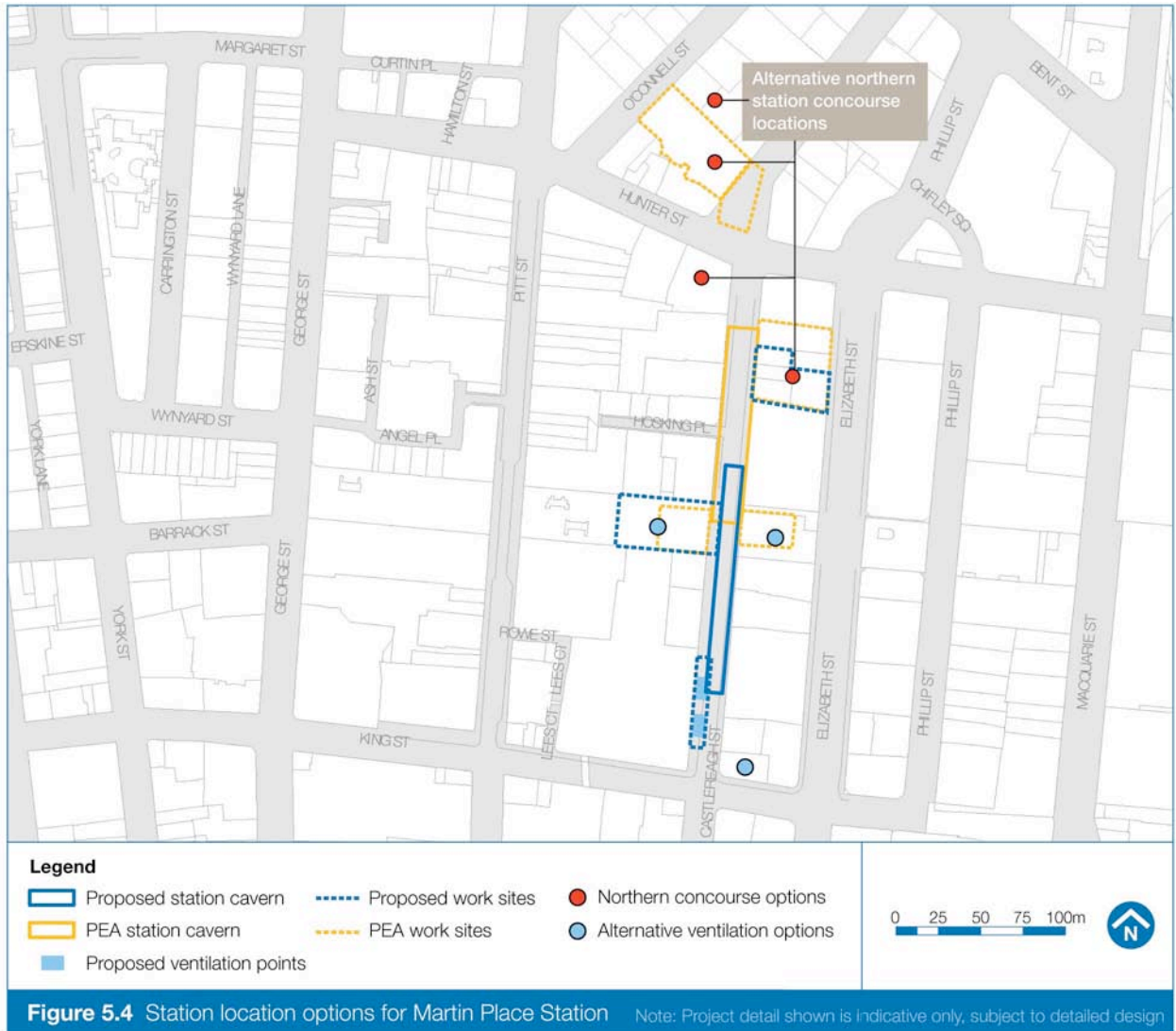
Refining the station location and design

A number of issues with the PEA scheme were identified as the design process progressed. These included the need to locate ventilation facilities in the public domain and the costs associated with the Kindersley House station concourse being located remote from the station cavern. More importantly, however, changes at Martin Place were required to accommodate the revised alignment following Margaret Street at Wynyard.

The Reference Design has the station cavern moved to the south to accommodate the new alignment (Figure 5.4). Alternative station ventilation options were also investigated in detail (also shown in Figure 5.4). To minimise visual, heritage and property impacts, the preferred location for these services is on Castlereagh Street. The progression of station location and design options is summarised in Table 5.3 with the proposed option identified as 'D' within the table.

Table 5.3 Progression of station location and design options for Martin Place Station

ID	Description	Key considerations	Key issues
A	PEA station	Best solution reflecting desire to have a northern entrance.	Need to locate ventilation facilities in the public domain. Costs associated with the Kindersley House station concourse being located at a distance from the station cavern. Significant property costs.
<i>[Changes at Martin Place were required to accommodate the revised alignment following Margaret Street at Wynyard]</i>			
B	Station box with entrance in Martin Place and major construction site identified	Provided major construction site between Elizabeth and Castlereagh streets. Services provided within the site between Elizabeth and Castlereagh streets, with future development potential maintained.	Property impacts on 11 Elizabeth Street and the Chifley Arcade. Ventilation facilities at southern end still unresolved.
<i>[Ventilation studies undertaken]</i>			
C	Various options to solve ventilation requirements explored	Ventilation facilities located in various locations, including: <ul style="list-style-type: none"> • within Martin Place • property at corner of King and Castlereagh streets • within the road reserve of Castlereagh Street • within the western footpath of Castlereagh Street • within the eastern footpath of Castlereagh Street. 	Various property impacts and technical issues. Various cost implications of different solutions. Visual impacts within Martin Place. Construction impacts on Castlereagh Street. Heritage considerations.
D	Proposed – Station box with entrance in Martin Place and major construction site identified	Provides major construction site between Elizabeth and Castlereagh streets (reduced footprint to avoid 11 Elizabeth Street). Services provided within site between Elizabeth and Castlereagh streets, with future development potential maintained. Ventilation facilities provided on western side of Castlereagh Street.	N/A



5.5.4 Barangaroo-Wynyard

Why a metro station at Barangaroo-Wynyard?

The Barangaroo-Wynyard Station would:

- Provide an opportunity for an interchange with CityRail services on the Bankstown, Inner West, Airport/East Hills, South, North Shore, Western and Northern lines.
- Provide bus interchange opportunities for bus passengers coming over the Harbour Bridge who need to access other parts of the CBD or to the west, including Pyrmont. Station entrances to the east would provide for bus interchange while servicing the financial core east of George Street, which is projected to have 112,000 workers by 2051. Station entrances to the west would service an area with a projected working population of 78,000 by 2051 and which includes Barangaroo, the Westpac, KPMG, Macquarie Bank and Lend Lease buildings.
- Bring significant 'place-making' opportunities with its role as a gateway to Barangaroo, the future financial core of the CBD and The Rocks precinct. Provide for interchange with ferries at a future Barangaroo Ferry Terminal, allowing easy access to other destinations in the CBD.
- Enable the realisation of the Barangaroo Pedestrian Link, which is a significant government commitment for the Barangaroo development site.

Locating the station and station entrances

While a number of station locations were explored along the PEA alignment, these were superseded by the need to shift the alignment to Margaret Street to achieve better interchange outcomes and more effectively service the Barangaroo site. The revised alignment facilitates a station with entrances at 30 Clarence Street, Transport House (York Lane via Margaret Street), Railway House (York Lane via York Street) and directly adjacent to the Barangaroo site. A comparison between the revised location and the options on the PEA alignment is shown at Figure 5.5. The progression of station location and design options is summarised in Table 5.4. The revised station location would achieve better opportunities than the PEA alignment for interchange with CityRail services at Wynyard and more direct access to the Barangaroo site.

Design refinements and construction options

In addition to less than optimal interchange times, the PEA location had the station positioned remote from the Barangaroo Pedestrian Link and would have created difficulties for access to the eastern side of York Street. There were also heritage issues associated with the location of ventilation facilities adjacent to St Phillips' Anglican Church (on Jamison Street).

The revised station location (identified as option 'G' within the table) addresses the interchange with a direct interface to both CityRail's Wynyard Station and the Barangaroo Pedestrian Link. The new position also responds to confirmed basement levels of various buildings in the vicinity of the station.

The preferred station entrance at 30 Clarence Street would result in the demolition of this building and the building at 36-38 Clarence Street. Components within the ground floor of Transport House would be removed, to allow for the construction of the station entrance and provision of retail space.

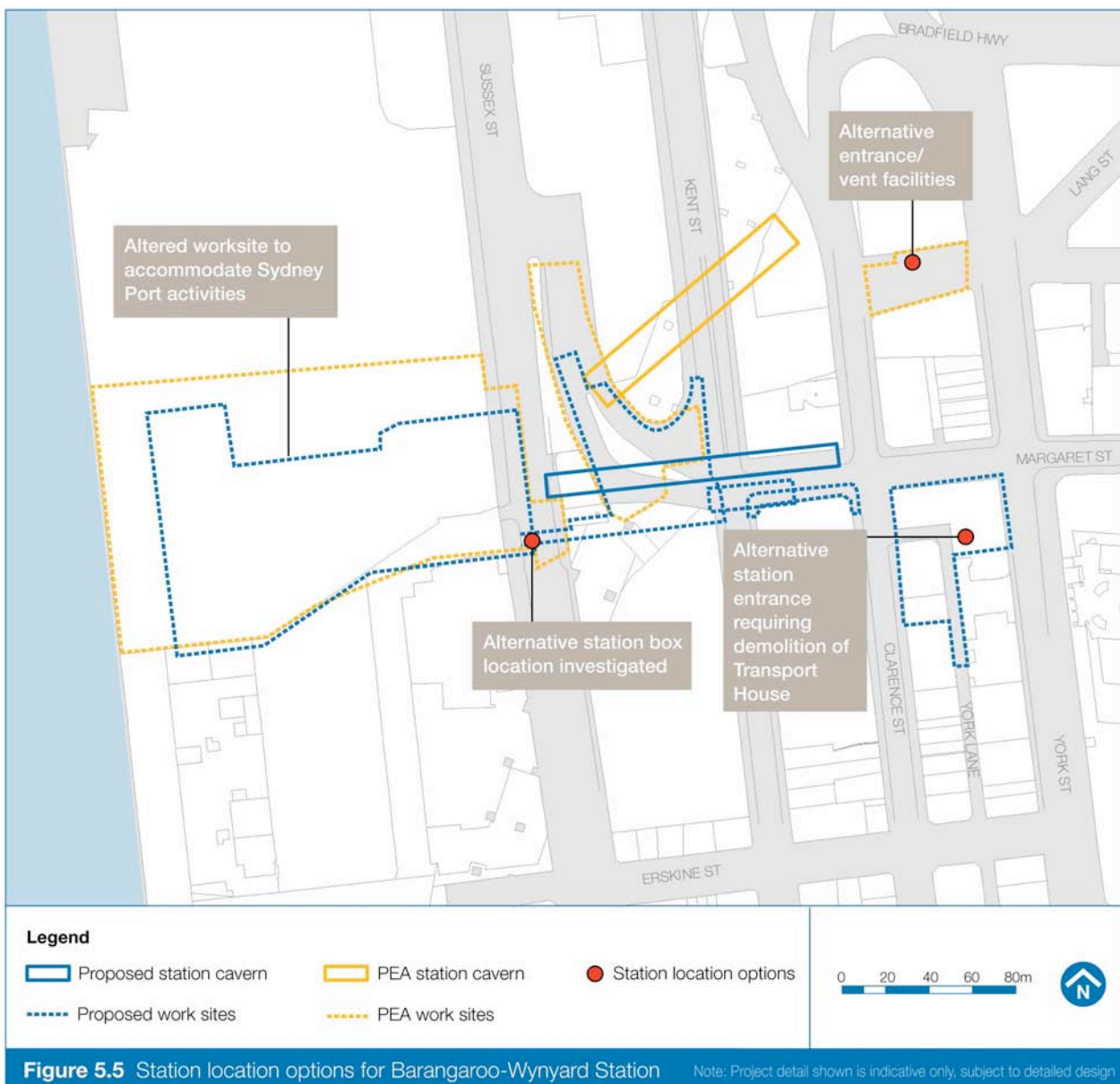
Revised worksites reflect the new alignment and station entrances, as well as modifications as a result of consultation with Sydney Ports to accommodate their activities. The PEA and currently proposed worksites are shown on Figure 5.5.

Table 5.4 Progression of station location and design options for Barangaroo-Wynyard Station

ID	Description	Key considerations	Key issues
A	PEA station	Best solution reflecting desire to have a northern entrance.	Very poor metro to CityRail passenger transfer. Construction traffic impacts on Jamison Street. Did not facilitate delivery of the Barangaroo Pedestrian Link.
B	Variations to PEA station	While a number of station locations were explored along the PEA alignment, these were superseded with the need to shift the alignment to Margaret Street to achieve better interchange outcomes and more effectively service the Barangaroo site.	Variations to the PEA station (Option A) did not achieve adequate metro to CityRail passenger transfer.
<i>[Revised alignment developed following Margaret Street at Wynyard to achieve better opportunities for interchange with CityRail services at Wynyard and more direct access to the Barangaroo site. The alignment change resulted in some (acceptable) compromises to track curvature to achieve this benefit]</i>			
C	Station cavern below Margaret Street with entrances in Napoleon Street area and Wynyard Park	Transfers to CityRail and bus greatly improved. Facilitated delivery of the Barangaroo Pedestrian Link.	Transfer to CityRail and bus still not adequately resolved (transfer times still not acceptable). Direct impacts on existing and proposed RailCorp corridors. Significant construction impacts, including traffic issues (cut & cover of Kent Street). Impacts on Wynyard Park and significant loss of open space. Heritage impacts.
D	Station cavern below Margaret Street with entrances in the Barangaroo development site area and Transport House	Significantly improved connections to CityRail. Facilitates delivery of the Barangaroo Pedestrian Link with improved connections. Direct connection to Barangaroo development site.	Bus connections still only adequate. Detailed design at Barangaroo site subject to development options. New impacts on property (demolition of Transport House) and business impacts on tenants in and adjacent to Transport House.
<i>[Additional information on complexity of Transport House – significant electrical transformers and RailCorp substation located in building that cannot be moved. In addition, complex shared services arrangements, including fire escape facilities, shared with adjoining building.]</i>			
E	About seven options to retain Transport House investigated	Retain entrance in Transport House without demolition of the building.	Technically unsound - station unable to be constructed. Tenants of Transport House and adjoining building would still require relocation.
F	Station cavern below Margaret Street with entrances in the Barangaroo development site area and 30 and 36-38 Clarence Street	No change to western entrance at Barangaroo development site. Retain Transport House, although works on ground floor and basement still required.	Initial designs had confusing or inadequate circulation for pedestrians/passengers. Initially linked poorly with the Barangaroo Pedestrian Link. Proposed closure of the Kent



ID	Description	Key considerations	Key issues
		Maintained good connections to CityRail. Improved connections to bus facilities, including direct link to west of Clarence Street. Facilitated excellent public domain improvements in York Lane consistent with the City of Sydney Council's activation of laneways policy.	Street Pedestrian Tunnel. New property impacts.
G	Proposed – improvements to Option F to achieve satisfactory circulation	As above, but significant improvements to horizontal and vertical circulation.	



5.5.5 Pymont

Why a metro station at Pymont?

A metro station at Pymont would be a key destination station. It would:

- Serve the employment areas around Darling Island to the east and Saunders Street to the west. It would also serve a mixed residential catchment and a range of attractors including Darling Harbour (Maritime Museum, Aquarium, Exhibition Centre and Harbourside etc), Star City Casino, strong employment generators on wharves 7-10 and at the Bank Street/Miller Street areas, new residential development around the north of the peninsula and the Fish Market.
- Provide interchange opportunities with light rail services and buses.
- Serve the strong pedestrian links to Glebe and Darling Harbour.
- Potentially act as a catalyst for urban improvements in the adjacent areas.

Locating the station and station entrances

A number of station location options were considered for the Pymont precinct. They were:

- Union Square.
- Near the light rail station at the Harvey Street/Scott Street intersection.
- Near the light rail station at John Street.
- Underneath Jones Bay Road and adjacent to the casino.
- Star City hotel site.
- The block between Harris and Pymont streets.
- Union Street (closing this street to traffic).
- The block between Mount and Harris streets.

These locations are illustrated in Figure 5.6. The Union Square option was selected as the preferred location in the PEA predominantly due to the advantages in reinforcing and servicing the village centre, and proximity to Darling Harbour. This location also takes greatest advantage of the strong east-west pedestrian/cycle desire lines and connections through the area.

Given the scope and nature of potential impacts at Pymont (namely, heritage, noise, economic and social impacts) and the considerable community concern, an options assessment report has been prepared as part of this Environmental Assessment (refer to Appendix C *Pymont Station: review of station options*).

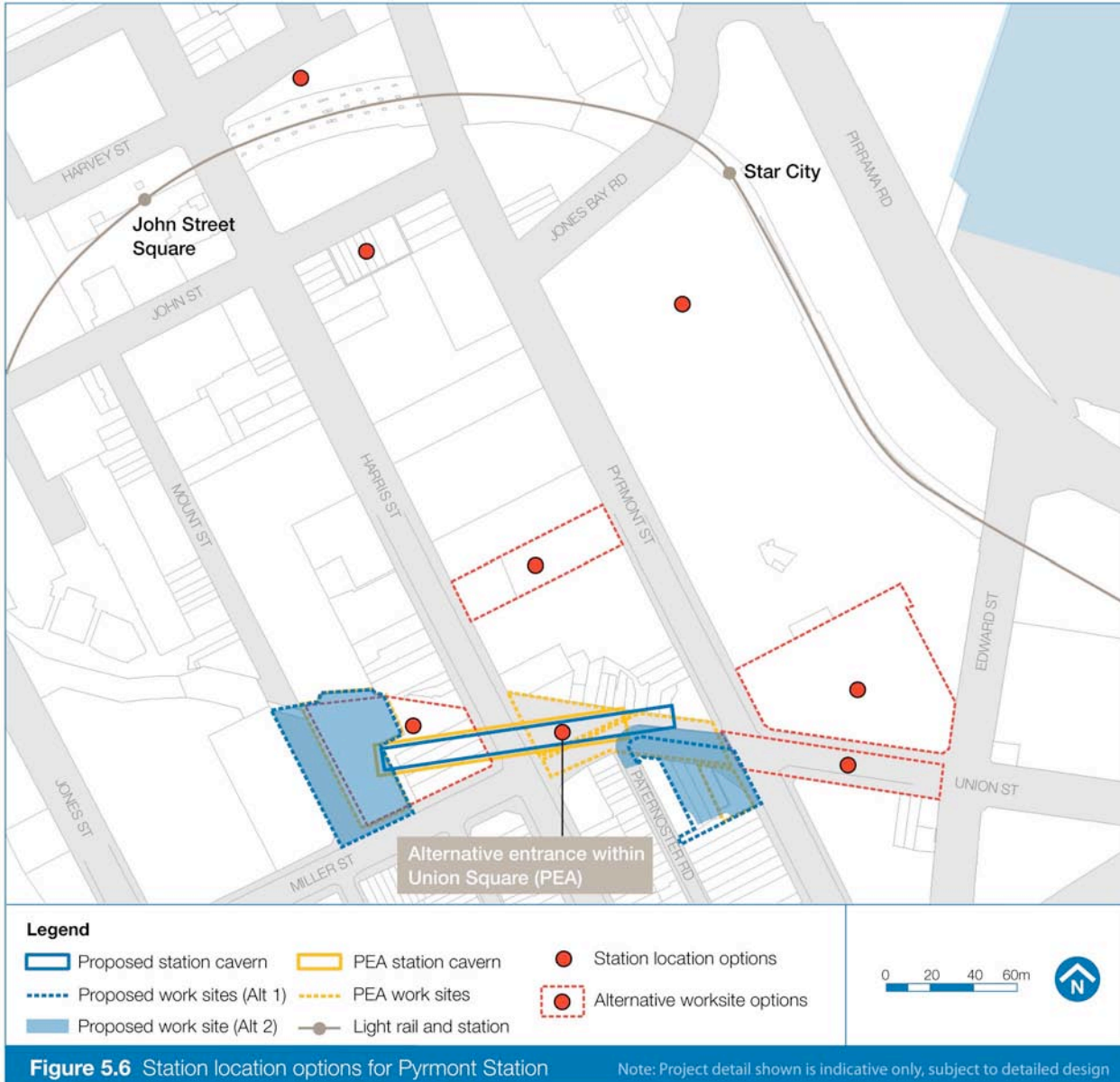
Refining the station location and design

The scheme for Pymont Station shown in the PEA would have had substantial impacts on Union Square and reflected a number of uncertainties. It was not clear whether an additional entrance to the west would be required and it was not clear whether part of the Star City hotel site could be used for a station entrance.

The proposed scheme (identified as option 'G' within the table) responds to these issues. Impacts on Union Square are reduced through the establishment of a larger than previously planned construction site at the corner of Union and Pymont streets. Two alternatives for this construction site have also been proposed. Alternative 1 would occupy all of the site at 3-9 Union Street, whereas Alternative 2 would occupy only part of the site at 3-11 Union Street. Further detail on these two alternatives is provided in sections 6.4.6 and 7.7.6. The proposed scheme also includes a western entrance.



The Star City hotel was not preferred as a station entrance site due to the likely difficulties in integrating the station entrance with the development of the site. The Minister for Planning approved the Star City hotel on 27 January 2009 and construction on the site is already underway. The station location options and proposed worksites are shown in Figure 5.6.



5.5.6 White Bay

Why a provision for a metro station at White Bay?

Provision for a station at White Bay addresses the future redevelopment of government-owned lands within the Bays Precinct and the possible location of a second international passenger terminal.

Potential interchange opportunities with a future White Bay Station may involve future ferry and bus services.

Station location options

The intention was to safeguard a station area for future construction and therefore a wide range of location options were not considered. In this regard, the following considerations were relevant:

- The requirement for a straight and level alignment through the vicinity of the station site.
- The need to construct a station box to an extent which allows the station construction and fit-out to be completed with minimum disruption to the operations of the metro.

Design refinements and construction options

There were no substantial changes to the White Bay Station site or configuration as outlined in the PEA. Detailed design of the future White Bay Station is yet to be fully considered. This would be undertaken in conjunction with the future masterplan to be prepared for the precinct.

5.5.7 Rozelle

Why a metro station at Rozelle?

As outlined in Section 5.3.2, a metro station at Rozelle would serve the densely populated residential precincts of Balmain, Rozelle and Lilyfield, including the café/restaurant and shopping strip along Darling Street towards Balmain.

In the early years of operation, it would have a significant bus-metro transfer function allowing rapid access to the CBD. While this function would diminish with the future extension of the metro network towards the north-west, local-level interchange would continue, particularly from the Balmain and Lilyfield / Leichhardt directions.

Locating the station and station entrances

A number of station location options were considered for Rozelle Station. They were:

- Under Victoria Road at the intersection with Darling Street.
- Partially under Victoria Road at the intersection with Darling Street, and the properties on the eastern side of Victoria Road, between 665 to 669 Darling Street and 670 to 672 Darling Street.
- Balmain Leagues Club site.
- Carrier Site, east of Victoria Road and adjacent to Terry Street.
- Eastern edge of Callan Park adjacent to Manning Street.
- Western side of Victoria Road, two options south of Darling Street.

The preferred location (as shown in the PEA) has the station positioned adjacent to the Victoria Road Darling Street intersection and partially under Victoria Road. This location has a substantial walk-up catchment and provides opportunities for effective bus transfer. This site was also seen as providing



an opportunity to improve the community setting of the St Thomas Church Group, Rozelle Public School and St Paul's Church while facilitating an improved link across Victoria Road.

Station options at the Carrier Site and Callan Park would not respond to the catchment areas and would not provide direct access to active retail areas. Station options to the south on Darling Street had greater heritage, property and amenity impacts when compared with the preferred location.

Design refinements and construction options

The PEA station location reflected a number of uncertainties and assumptions. As more information became available during the design development process, opportunities to refine the station location and design were identified. Issues with the PEA location included:

- Uncertainties surrounding the requirements for bus interchange – it became apparent that further land would be needed to accommodate transfer facilities for outbound buses.
- Requirement for a partial purchase of the St Thomas property and impacts associated with construction works.
- Construction issues associated with access shafts located above the station cavern.
- Uncertainties surrounding alignment constraints.

The proposed scheme for Rozelle responds to these issues (identified as option 'J' within the table). The number of properties directly affected would be reduced and the Balmain Leagues Club site used for construction as it would be more accessible for construction purposes. Its use would result in fewer construction impacts and provide an opportunity for the future development to integrate with the metro station. Alignment constraints that originally precluded a station cavern in the proposed location have now been resolved.

Revised worksites reflect the new station cavern position, entrances and construction methodology. The PEA and proposed worksites are shown on Figure 5.7. The progression of station location and design options is summarised in Table 5.5.

Table 5.5 Progression of station location and design options for Rozelle Station

ID	Description	Key considerations	Key issues
A	Station cavern below York Buildings	Initial location identified but discarded due to heritage impacts and constructability issues.	Significant heritage impacts. Construction issues.
B	PEA Station	At Darling Street intersection and partially under Victoria Road to provide for substantial walk up catchment and opportunities for effective bus transfer. Opportunity to improve the community setting.	Uncertainties surrounding the requirements for bus interchange. Property impacts. Construction issues. Uncertainties surrounding alignment constraints.
C	Station cavern moved south under Victoria Road	Use of the Balmain Leagues Club site for construction and permanent works. Reduced impacts on the St Thomas property (location of child care facility).	Uncertainties surrounding alignment constraints. Poor urban design outcome with station entrance removed from 'high street' location on Darling Street. Significant property-take. Poor ability to transfer to buses.

ID	Description	Key considerations	Key issues
D	Options that include only two entrances considered	Reduced property impacts (permanent works) and cost.	Reduced access for walk up catchment. Poor ability to transfer to buses. Construction impacts remained similar to options with three entrances.
<i>[Improved understanding of bus interchange requirements developed.]</i>			
E	Alternative location of services on south-eastern side of Victoria Road	Attempted to reduce property impacts of permanent works.	Property impacts remained. New property impacts. Poor ability to transfer to buses.
<i>[Resolved alignment issues and confirmed station depth]</i>			
F	Station cavern fixed under Victoria Road	Use of the Balmain Leagues Club site for construction only. Reduced impacts on the St Thomas property (location of child care facility) and St Paul's property (reduced construction footprint).	Bus transfer remained unresolved. Complicated vertical circulation and only adequate transfer times.
G	Improvements to Option F to improve transfer to buses	As above, but improved design of bus facilities, including provision of a bus bay within the Balmain Leagues Club site.	Complicated vertical circulation and only adequate transfer times.
H	Option testing the use of high speed lifts	Attempted to improve vertical circulation. Reduced costs.	Did not resolve circulation issues. Long-term maintenance issues and lack of precedents.
I	Improvements to Option G to achieve satisfactory circulation	As above, but significant improvements to horizontal and vertical circulation.	
J	Proposed – Improvements to Option I to maximise bus interchange	Good bus interchange arrangements. The number of properties directly affected is reduced. Balmain Leagues Club site is utilised for construction, resulting in fewer construction impacts and providing the opportunity for the future development to integrate with the metro station.	



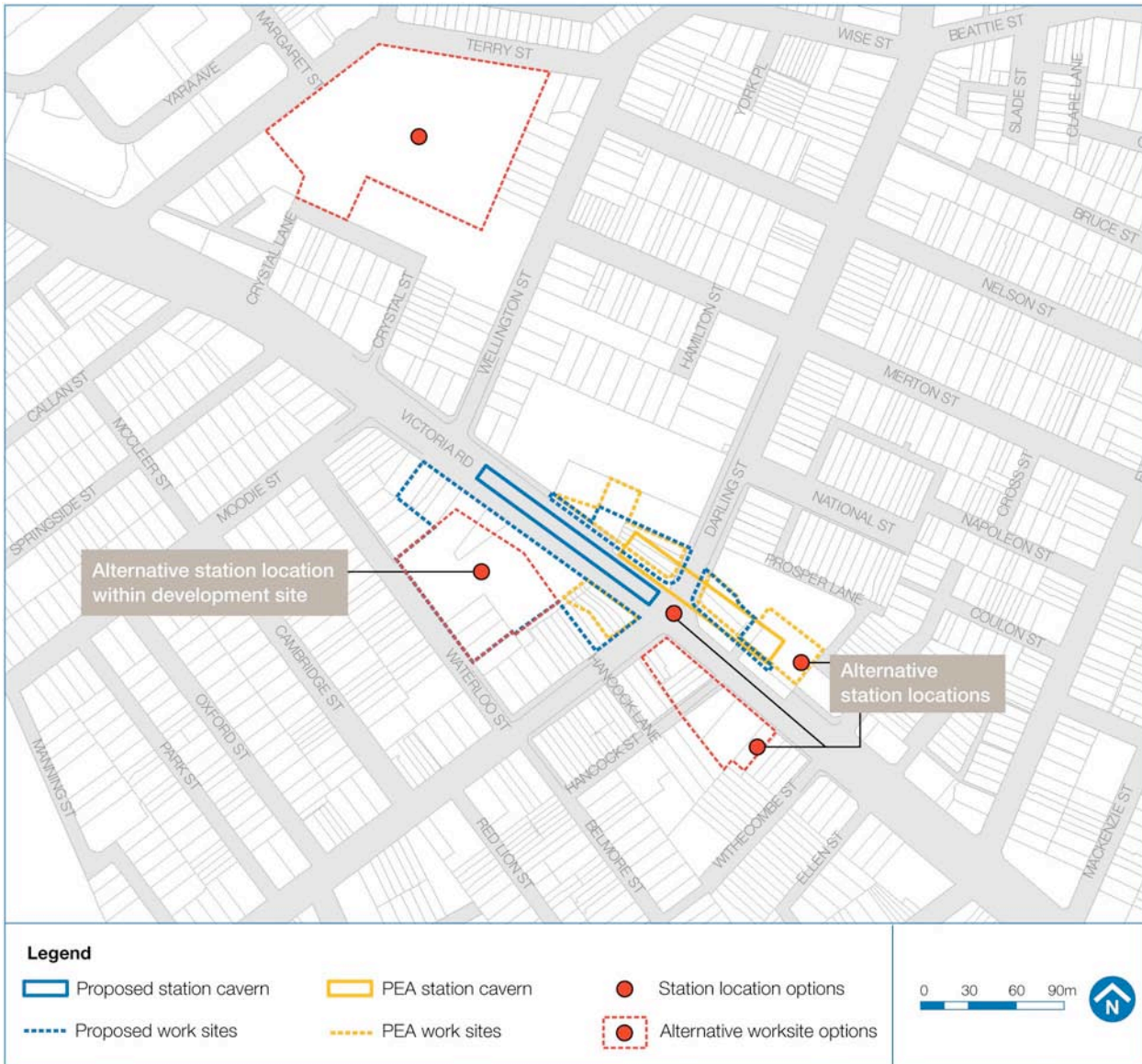


Figure 5.7 Station location options for Rozelle Station Note: Project detail shown is indicative only, subject to detailed design

5.6 Stabling and maintenance depot

The preferred alignment of the CBD metro dictated that the only possible location for the stabling and maintenance depot would be at the former Rozelle Marshalling Yard site (see Figure 6.21).

There are no other areas along the proposed route with the capacity to accommodate the depot. It is also a desirable location for operational reasons.

Key considerations in selecting the depot site were:

- Ability for efficient metro operations.
- Stabling capacity for an initial fleet of 13 trains for the CBD Metro.
- Scope for expansion to accommodate future metro lines, with stabling for 30 six-car trains and maintenance capacity for 59 six-car trains. (It is noted that any expansion of this facility would be subject to a separate planning assessment and approvals process.
- Suitable areas for presentation and washing facilities.
- Sufficient space for infrastructure maintenance areas, stores and parking.
- Access roads suitable for long vehicles.
- Suitable area for buildings that are not directly related to maintenance, including administration and training, traction power and bulk supply substations.
- Opportunity for adaptive reuse of a former rail site.

Trains would enter and exit the depot from the running tunnels through portals located within the depot site. The design of the portal and the entry/exit tunnels is constrained by:

- Physical constraints such as the location of the depot, the location of White Bay Station, the topography of the land, local flood levels, and existing structures such as the Victoria Road Bridge
- Operational design criteria such as the curve radii of entry and egress tracks.

Taking these physical and operational constraints into consideration, four options were developed for the entry and egress of trains to and from the depot. The options are:

- Option 1 – Two parallel tracks entering the portal in the cliff face, about 100 metres from the Victoria Road bridge.
- Option 2 – Two parallel tracks entering the portal in the cliff face, about 100 metres from the Victoria Road bridge but lowered by one metre to increase the depth of rock under the affected residences. This option also includes an acoustic enclosure that would extend from the portal beyond the end of the entry and egress curves by a distance of 70 metres.
- Option 3 – Two non-parallel tracks entering the portal immediately adjacent to the Victoria Road bridge abutments. These tracks would have a much tighter curvature than options 1 and 2.
- Option 4 – Two non-parallel tracks entering the portal immediately adjacent to the Victoria Road bridge abutments. The Up connection track would pass under the Victoria Road Bridge and would have a tight curvature. The Down connection track would be tunnelled under the Victoria Road bridge at about right angles to the bridge to improve the Down track curvature. This option would require White Bay Station to be moved about 25 metres to the east.



Options 3 and 4 were eliminated due to unacceptably tight track curve radii, which would result in:

- Reduced train speed on entry and egress.
- Increased wheel and rail wear.
- Increased likelihood and severity of air-borne wheel squeal noise.
- Compromised future access to the White Bay station precinct.

Options 1 and 2 would both maximise track curve radii to the same degree and therefore:

- Maximise the speed on entry and egress.
- Minimise wheel and rail wear, thus minimising recurrent maintenance requirements.
- Minimise the likelihood of air-borne wheel squeal noise.

Subject to flood and drainage studies, Option 2 is preferred over Option 1 as it would:

- Increase the depth of rock between the portals and nearby residences, thereby reducing the potential for ground-borne noise.
- Reduce the potential for air-borne noise by installing an acoustic enclosure that incorporates sound absorption material.

The acoustic enclosure would be landscaped to provide an aesthetically pleasing view from residences.