6 Project Description

6.1 Introduction

A Concept Design for Melbourne Metro has been developed that demonstrates a technically feasible way for the project to be developed that meets the Victorian Government's objectives and the recommended Environmental Performance Requirements documented in this EES. The Concept Design, alternative design options and proposed construction methodology provide the basis for assessing the potential environmental risks and impacts of Melbourne Metro and for demonstrating that impacts can be managed.

Melbourne Metro incorporates four key components which are evaluated in this EES:

- The Concept Design and specific alternative design options
- Proposed construction methodology
- The environmental impact assessment (underpinned by a risk assessment)
- The recommended Environmental Performance Requirements.

Each component has evolved as the baseline investigations and technical assessments have identified issues that required the Concept Design, indicative construction methodology or the Environmental Performance Requirements to be refined.

This chapter describes the Concept Design components and options to these components, as summarised in Table 6–1. The alternative design options include feasible alternatives for vertical alignment above or below the CityLink tunnels; emergency access shaft locations; the southern TBM launch facility location; and the western portal design configuration. Contractors tendering to construct Melbourne Metro would finalise the detailed design, including final selection of each of the design options. An indicative construction methodology is also described in this chapter.

Plans of the Concept Design and its components during construction and operation are provided in the EES Map Book. Potential construction methods are described in Section 6.6 of this chapter.

Contractors tendering to construct Melbourne Metro may offer alternatives to its design or configuration compared to the Concept Design that deliver better value for money or that incorporate innovative approaches in design, technology, operations or construction techniques. Further design refinement may also be required as the detailed design is developed and stakeholder requirements are addressed.

It is envisaged that refinements to the design would be contained within the proposed Project Area and would comply with the recommended Environmental Performance Requirements – therefore, no further assessment would be required. However, if the alternatives do not meet these conditions, further impact assessment and approvals could be required subject to the decision of the Minister for Planning.

Table 6–1 Concept Design components and options

Components		Description of components and options
Tunnels	Vertical alignment	The vertical alignment of the Concept Design is largely prescribed by the grade line and connection to Melbourne Central and Flinders Street Stations. The two tunnels would be 9 km long with a diameter of 7 m to 7.5 m. Along the tunnel alignment, the proposed rail level would be typically between 10 m to 40 m below ground level and pass under the existing City Loop tunnels. The deeper vertical alignment within the CBD has been chosen to minimise disruption to the CBD during construction and to avoid the City Loop tunnels. The Concept Design prescribes the use of tunnelling or mined construction methods (between CBD stations) for the tunnel to minimise surface impacts.
	Yarra River crossing	The Concept Design requires a bored tunnel under the river with the alignment largely prescribed based on connection to the CBD South station.
	Crossing of CityLink tunnels (options)	The Concept Design considers options to cross either above or below the CityLink tunnels between CBD South and Domain stations.
	Emergency access shafts (options)	Two shafts may be required. The Concept Design considers alternative locations for each shaft: • Fawkner Park – North-east section of Fawkner Park or – At the potential TBM southern launch site location at and surrounding the current Fawkner Park Tennis Centre • Linlithgow Avenue – Queen Victoria Gardens adjacent to Linlithgow Avenue or – Tom's Block adjacent to Linlithgow Avenue. The final location and requirement for emergency access shafts would be determined in consultation with the Metropolitan Fire Brigade.

Components		Description of components and options
	TBM launch sites (options for southern launch site)	The Concept Design requires two TBM launch sites. The western TBM launch site is to be at the Arden station site to support construction of the tunnels west of the Yarra River. The southern TBM launch site considers alternative locations: • Single launch site at Domain station box, or • Two launch sites at the Domain station box and a defined section in the north east corner of Fawkner Park (where tennis courts are located). Both options for the southern TBM launch require tunnelling activities to be supported by construction work site at Edmund Herring Oval.
Portals (tunnel entrances)	Western portal (Kensington) (options)	The western portal would be located immediately north of the South Kensington station. The Concept Design considers two portal locations, which consider variations in vertical and horizontal alignments that are influenced by position of the tunnel entrance/exit point (the portal). A number of options were considered, but only two options have been assessed in the EES (see Chapter 5 *Project Development* for further discussion of options considered). One option positions the portal within the council reserve on the south side of Childers Street directly to the west of the South Kensington station subway entrance located opposite Ormond Street. The second alternative option positions the portal within the council reserve on the south side of Childers Street approximately 150 m west of the South Kensington station subway entrance located opposite Ormond Street, with a longer decline structure to enter the tunnel and a bridge over Kensington Road.
	Eastern portal (South Yarra)	The Concept Design is prescribed regarding the location of the eastern portal and is influenced by design standards required for crossing of the Sandringham and Frankston rail lines. A TBM retrieval box (incorporating other plant) would be required in the rail reserve between Osborne Street, South Yarra and the existing Sandringham Line.
Underground stations	Arden	The Concept Design is prescribed regarding station location (between Arden and Queensberry Streets, contained within publicly owned land) and construction method (bottom-up cut and cover station box construction). Initially the station would have an entrance located on Laurens Street. There would be provision for a future second entrance located approximately 120 m south of Arden Street, in line with a future southward extension of Fogarty Street.
	Parkville (construction options)	The Concept Design is prescribed regarding the station location (under the Grattan Street road reserve, to the east of Royal Parade) and considers two possible construction options: top-down cut and cover construction or bottom-up cut and cover construction. Two entrances would be located at the University of Melbourne, one on the corner of Royal Parade and one on Grattan Street. A further entrance would be located outside the Victorian Comprehensive Cancer Centre (near the corner of Royal Parade). A tram stop would be located in Royal Parade, just north of Grattan Street.

Components		Description of components and options
	CBD North	The Concept Design is prescribed regarding the station location (under Swanston Street, between Franklin and La Trobe Streets) and construction method (mined cavern). One entrance would be located on the Franklin Street, to the east of Swanston Street and another entrance on the corner of Swanston and La Trobe Street, with an underground connection to Melbourne Central Station. A plant room would be located under Franklin Street (between Swanston and Bowen Streets).
	CBD South	The Concept Design is prescribed regarding the station location (under Swanston Street, between Collins and Flinders Streets) and construction method (mined cavern). One entrance would be located on Collins Street at City Square and one entrance would be located on Flinders Street, opposite to and with an underground connection to Flinders Street Station. There would be an underground entrance connection to Federation Square.
	Domain	The Concept Design is prescribed regarding the station location (under St Kilda Road, adjacent to Albert Road) and proposed construction method (cut and cover, with a mix of top-down and bottom-up). The station would have three entrances: within the Shrine of Remembrance Reserve, within the Domain tram interchange in St Kilda Road and within open space between Albert Road and St Kilda Road where the South African Soldiers Memorial is located.
Turnback	Western turnback at West Footscray	The Concept Design is prescribed regarding the locations of the turnback and the requirement for a third platform and track at West Footscray station, with modifications to the existing concourse.
Electrical substation	Arden (options)	The Concept Design considers four options: • North of Arden Street, between CityLink to the west and Langford Street to the east • Co-location at Metro Trains Melbourne traction substation between CityLink and the Upfield line • Southern section of the Arden station precinct, between rail to the west and Laurens Street to the east • In the existing 50 Lloyd Street Business Estate at the eastern corner of Childers and Tennyson Streets (dependent on the western portal option).

6.2 Design Requirements

Key requirements for the design of Melbourne Metro are:

- Two tunnels each containing one track each
- Five stations located at Arden, Parkville, CBD North, CBD South and Domain that maximise patronage use and connectivity to other public transport services
- Station platforms with a minimum length of 222 m to accommodate HCMTs
- Portals at Kensington in the west to connect with the Sunbury line and South Yarra in the east to connect with the Dandenong rail corridor (Cranbourne/Pakenham line)
- Where possible, tunnels are located under existing road reserves to minimise the requirement to acquire and/or disrupt existing land uses
- Tunnels would be constructed largely with TBMs
- Stations would be constructed using cut and cover method for Arden, Parkville and Domain stations and mined cavern construction for CBD North and CBD South stations
- Station entrances would be designed to be protected from a 1:100 year flood associated with stormwater drainage and a 1:1000 year flood associated with a waterway
- Tunnel cross-passages would be located between the two tunnels at various locations, provided in accordance with fire and life safety requirements
- Emergency access shafts providing access to the two tunnels for emergency services only when the distance between a portal and station or between two stations is greater than 1.8 km. These shafts must be directly above the tunnels and located close to roads and access for emergency services
- Tunnel, station and portal permanent infrastructure would be designed as tanked undrained structures to limit groundwater inflow during operation.

The design standards to be adopted for Melbourne Metro are based on standards and building codes relevant to rail design and construction.

6.3 Project Schedule and Delivery

It is estimated that the period between award of the main construction contract for Melbourne Metro and the commencement of passenger services would be about nine years.

The proposed schedule for the construction of Melbourne Metro is provided in Table 6–2. This timeframe assumes the following key dates are met:

- Commencement of enabling works – 2016

- Tunnels and stations main contract awarded – late 2017/early 2018
- Vacant land possession – 2018.

Table 6–2 Key project schedule dates

Date	Activity
2015-2016	• Site investigations • Complete development of Melbourne Metro Concept Design • Community consultation • EES submitted, exhibited and assessment released by the Minister for Planning • Prepare and submit Business Case • Enabling works before major construction
2017 – 2018	• Finalise planning and environmental approvals based on Minister for Planning's assessment • Procurement for major construction contract • Early works before major construction • Award major construction contract for tunnels and stations • Start major construction works • Demolition of acquired buildings
2022 – 2023	• Civil and structural works at stations, portals and tunnels completed
2024 – 2025	• Station fit out and rail systems installation completed
2025	• Systems integration and operational readiness
2026	**Project complete**

6.4 Proposed Project Boundary

The proposed project boundary encompasses the key locations that would be used for permanent structures and temporary construction work sites (above and below ground), with the exception of ancillary works associated with road functional layouts and tram diversion and service relocation.

The proposed project boundary provides the basis for the specialist assessments undertaken for the EES. For assessment purposes, the proposed project boundary has been divided into nine precincts to assess the potential impacts on local areas and the characteristics of surrounding area and communities.

For the purposes of the EES, the proposed project boundary is approximately 30 metres either side of the proposed tunnel alignment, except around the stations, portals and construction work sites where the project boundary is broader. Details of the proposed project boundary are provided in the EES Map Book appended to this EES.

Some of the assessments undertaken to inform this EES have adopted larger study areas than the proposed project boundary in order to appropriately characterise and understand relevant effects and to collect sufficiently detailed baseline information. Where this approach has been adopted, it is noted and described in the main EES report and in the specialist impact assessment reports appended to the EES.

The proposed project boundary and assessments undertaken for this EES have informed the 'draft project area' being exhibited with the EES.

6.5 Project Precincts and Components

For assessment purposes, the proposed project boundary has been divided into nine precincts, based on the location of project components and required construction works.

Table 6–3 Melbourne Metro Precincts' and Project Components

Precinct	Project Component
Precinct 1	Tunnels (outside other precincts)
Precinct 2	Western portal (Kensington)
Precinct 3	Arden station
Precinct 4	Parkville station
Precinct 5	CBD North station
Precinct 6	CBD South station
Precinct 7	Domain station
Precinct 8	Eastern portal (South Yarra)
Precinct 9	Western turnback (West Footscray)

Descriptions of the precincts and the components featured within them are provided in the following sections.

6.5.1 Precinct 1 – Tunnels

This precinct covers the alignment of the proposed two tunnels between the western portal at Kensington and the eastern portal at South Yarra, with the exception of the station and portal precincts.

Concept Design

The key features of the proposed tunnels alignment for the Concept Design are:

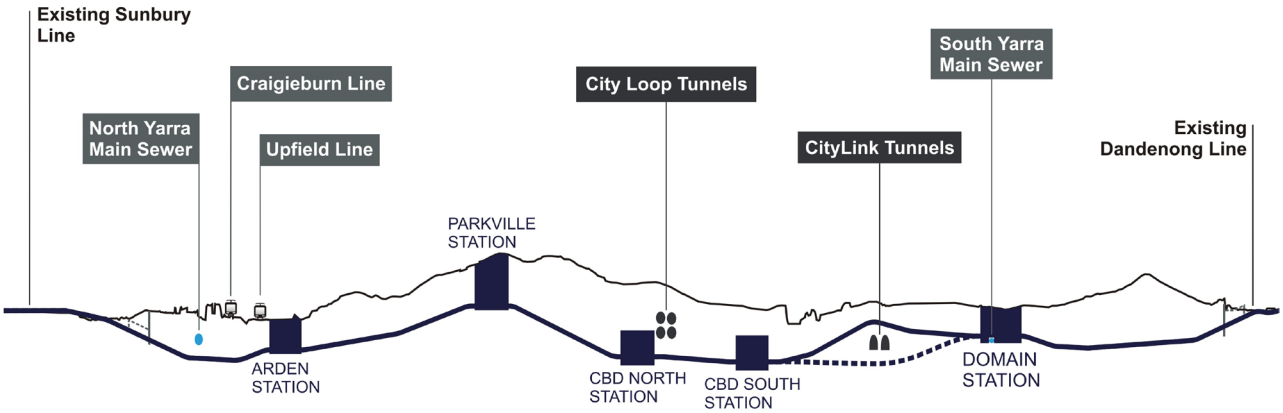
- From the western portal to the proposed Arden station, the two tunnels would run beneath the Craigieburn railway line, Moonee Ponds Creek and CityLink

- The tunnels would run in a relatively direct line between the proposed Arden and Parkville stations
- From Parkville station, the tunnels would turn south adjacent to Swanston Street to CBD North station
- From CBD North station to CBD South station, the tunnels would run beneath the Swanston Street road reserve
- From CBD South station, the tunnels would pass beneath the Yarra River, under and to the east of Princes Bridge
- The tunnels would pass beneath the Alexandra Gardens and the Queen Victoria Gardens and above or below the CityLink tunnels, before entering the St Kilda Road reserve and approaching the proposed Domain station
- South of Domain station, the tunnels would generally remain beneath the St Kilda Road road reserve. The tunnels would turn east to pass under Fawkner Park adjacent to Toorak Road and then enter and remain under the Toorak Road reserve until they approach the eastern portal (South Yarra) from around Macfarlan Street, where they would tie into the existing Dandenong rail corridor west of Chapel Street.

Along the two tunnels alignment, the proposed rail level would be between approximately 10 m to 40 m below the existing ground level. The deepest point would be adjacent to Swanston Street north of the CBD with the shallowest point being above the CityLink tunnels, if the above CityLink option proceeds. An indicative cross-section for the tunnels vertical alignment is shown below.

The alternative design option for the proposed vertical alignment considered by the EES is for the tunnels to pass below the CityLink tunnels.

Figure 6-1 Melbourne Metro indicative tunnels vertical alignment



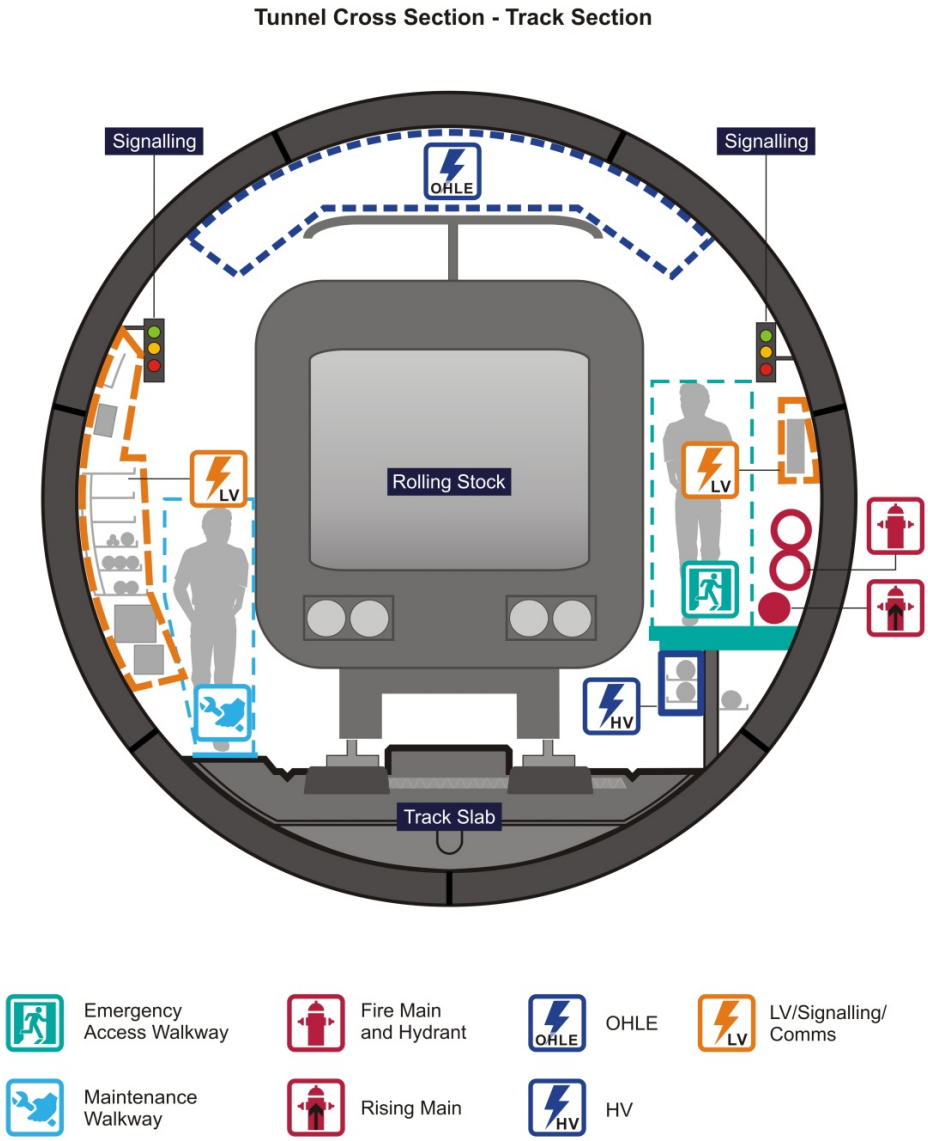
Infrastructure components

Infrastructure components proposed within this precinct are related to the excavation of the tunnels and include:

- Two 9 km tunnels with a diameter of 7 m to 7.5 m (with a tunnel length of 7.3 km excluding stations)
- Tunnel cross passages
- Emergency access shafts located:
  - In the north-east section of Fawkner Park or in Fawkner Park at the possible TBM southern launch site location at the current Fawkner Park Tennis Courts
  - In Queen Victoria Gardens adjacent to Linlithgow Avenue or in Tom's Block adjacent to Linlithgow Avenue
- Rail track and rail systems (including signalling, train control, communications, ventilation, overhead traction power supply and safety systems).

A representative tunnel cross-section is illustrated in Figure 6-2.

Figure 6-2 Example of internal tunnel cross-section (indicative only)



HV – high voltage cabling, LV – low voltage cabling, OHLE – overhead line equipment.

Construction Activities

Two sections of the proposed Melbourne Metro tunnels would be bored using TBMs: the western portal to CBD North station; and CBD South station to the eastern portal (refer also to Figure 6-12). The key construction assumptions for the tunnels are:

- TBM bored tunnel linings would be precast offsite (potentially at the Arden construction work site) and delivered to the relevant TBM launch site
- Interaction with groundwater during tunnel construction would be managed through design and selection of appropriate TBMs

- Contaminated soil would be handled and disposed of in accordance with the draft Spoil Management Strategy provided in Technical Appendix Q
- As with all tunnel projects, surface settlement would be a primary consideration in the design of the tunnel and the selection of construction methodologies and management measures, including advanced ground treatment where required. Ground improvement works would be required in Tom's Block if the final design crosses over CityLink tunnels
- Settlement monitoring during construction
- Installation of temporary construction power and cables to the TBM's at:
  - Arden: Alignment originating at the West Melbourne Terminal Station and likely to involve a bore beneath the Moonee Ponds Creek and CityLink. Trenching alignment alternatives include Arden and Barwise Streets and within the VicTrack land. These options are within the draft project land proposed for the project.
  - Domain, Fawkner and Osborne Street - Alignment commencing at the Richmond Terminal Station and finishing at the Domain tram interchange and Fawkner Park. Recovery Power supply would potentially be aligned along Osborne Street, although it is yet to be confirmed with the power utility. Options for power supply for TBMs launched at Domain station and possibly Fawkner Park are to be determined in consultation with the power utility, but would likely involve both boring trenching and/or crossing of existing structures (such as bridges). Undertaking the required assessment and obtaining approvals for the power supply for the TBMs would be the responsibility of the power utility.
  - Roadheader construction power - Alignments that connect to A'Beckett Street, Franklin Street and City Square. Undertaking the required assessment and obtaining and approvals for the power supply would be the responsibility of the power utility.
- Spoil removal by trucks would operate during day time hours. Where possible, 24 hour truck movements would be undertaken and with necessary mitigation measures applied
- Removal of trees at the start of construction and subsequent replacement of trees
- The section of the tunnels running between CBD North station and CBD South station is proposed to be mined, with excavation undertaken using roadheaders
- A TBM launch site in the western section of the project would be located at the Arden station site
- Two options have been considered when assessing TBM launch locations for the section between CBD South and the eastern portal:
  - Domain station or
  - Domain and Fawkner Park.

The preferred southern TBM launch option involves constructing shafts in St Kilda Road at both ends of the Domain station footprint, and setting up Edmund Herring Oval as a TBM support site. The TBMs would be driven from the shafts towards both CBD South and the eastern portal. The construction of Domain station would continue at the same time, also using Edmund Herring Oval as a construction work site.

The alternative option involves constructing shafts at both Domain station (under St Kilda Road) and Fawkner Park (under the tennis courts). The shaft at Fawkner Park would provide an additional option to launch TBMs towards the eastern portal and potentially back to Domain station. In order to construct the tunnels between Domain station and CBD South, TBMs would still need to be launched and serviced from Domain/Edmund Herring Oval. This option has been include to allow for the contractors to determine the most efficient way to construct the tunnels and to provide contingency if an additional TBM launch site is required.

The Domain TBM launch option only is preferred as it minimises the public open space requirements and for logistical reasons that the CBD South and Domain can only be constructed by launching from northern end of Domain.

Launching the TBM would require a range of support services at the TBM launch site, such as a grouting plant, gantry crane, spoil handling system, water treatment plant and facilities to assemble the TBM. The site would also be used for activities related to construction of the southern part of the proposed Melbourne Metro alignment, including site offices, materials laydown, equipment storage and maintenance.

The Concept Design assumes that construction techniques in some areas of the tunnel would include provision of ground support using precast reinforced concrete segmental lining and ground improvement. Construction of the Linlithgow Avenue emergency access shaft would include techniques such as king posts and retaining walls.

Further details on construction methodology and assumptions are provided in Section 6.6.

6.5.2 Precinct 2 – Western Portal (Kensington)

The western portal would be located adjacent to the existing South Kensington station and associated pedestrian underpass. The precinct contains housing, public open space and an industrial estate to the north, with railway lines and a freight terminal located to the south. JJ Holland Park is located to the north of the proposed portal and is an area of well-used public open space. Several residential properties are also located to the north of the proposed portal in Childers Street.

Concept Design

Melbourne Metro is proposed to connect the western end of the tunnel alignment to the existing rail network west of the South Kensington station. The western portal includes the approach from the existing surface rail corridor to the bored tunnels precinct (Precinct 1). The portal alignment works would include:

- Turnout of the existing Sunbury rail lines towards the new Melbourne Metro tracks with a diverge back to the existing surface level Sunbury lines, allowing services along the Sunbury line to enter the underground section while maintaining flexibility for trains to travel along the existing tracks to Southern Cross Station if needed (for example, during a disruption to normal services)
- Twin track decline structure immediately south of Childers Street to carry the Melbourne Metro tracks from embankment level to the cut-and-cover interface below ground
- Twin track cut-and-cover tunnel from the decline structure to the bored tunnel interface.

The Concept Design considers two portal locations with various vertical and horizontal alignments that influence the position of the tunnel entrance/exit point (the portal). A number of options were considered, but only two options have been assessed in the EES. Refer to Chapter 5 *Project Development* for further discussion of options.

The first positions the portal within the council reserve on the south side of Childers Street directly to the west of the South Kensington station subway entrance which is located opposite Ormond Street. This option consists of:

- A northerly track slew of the existing Sunbury surface lines commencing immediately east of the rail bridge over Kensington Road. The slew would align the existing surface lines with the new Metro rail
- A slight downward grade (1.3 per cent) of the slewed lines leading to a 1 in 9 turn-out with the straight leg heading for the new Melbourne Metro tracks and the diverge leading back to the existing surface level Sunbury rail line

- Reconfiguration of the existing Sunbury line rail for a distance of approximately 750 m
- Removal of the crossovers between the Sunbury line and Werribee line rail located immediately west of the South Kensington station
- Twin track decline structure with a 3 per cent gradient complete with up-stand flood retention wall immediately south of Childers Street to carry the Melbourne Metro rail from surface level at Childers Street to the cut-and-cover interface below ground
- Twin track cut-and-cover tunnel located along Childers Street from the decline structure to the bored tunnel interface, with the interface situated in Bakehouse Road on the east side of McClure Road within the western boundary of the 50 Lloyd Street Business Estate
- TBM retrieval shaft located immediately west of the bored tunnel interface.

The second option positions the portal within the council reserve on the south side of Childers Street approximately 150 m west of the South Kensington station subway entrance located opposite Ormond Street. This option consists of:

- A northerly track slew of the existing Sunbury surface lines commencing east of the rail bridge over the Maribyrnong River. The slew would align the existing surface lines with the new Metro tracks
- Embankment widening works supporting the slewed track work and a 1 in 9 turn-out with the straight leg heading for the new Melbourne Metro tracks and the diverge leading back to the existing surface level Sunbury Tracks
- An elevated structure including a rail bridge over Kensington Road
- Twin track decline structure with a 3 per cent gradient complete with up-stand flood retention wall immediately south of Childers Street to carry the Melbourne Metro tracks from surface level at Childers Street to the cut-and-cover interface below ground
- Twin track cut-and-cover tunnel with a 3 per cent gradient located south of Childers Street running from the decline structure to the bored tunnel interface, with the interface situated immediately west of the South Kensington station subway entrance
- TBM retrieval shaft located immediately west of the bored tunnel interface.

Refer to Chapter *5 Project Development* for further discussion of options.

Construction Activities

The main construction activities in Precinct 2 would be:

- Early works for the relocation and protection of utilities (including electrical and gas services) (refer to Section 6.5.10 for further details)

- Private property acquisition and demolition of buildings (note there is no commercial acquisition and only one residential acquisition for the alternative design option)
- Relocation of public car parking and shared use path
- Removal of trees at the start of construction and subsequent replacement of trees
- Temporary access arrangement to the 50 Lloyd Street Business Estate
- Embankment widening and stabilisation works leading to the decline structure
- Construction of a decline structure within the rail reserve immediately south of Childers Street
- Cut and cover tunnel construction along Childers Street between Ormond Street and the 50 Lloyd Street Business Estate (first option) and within the council reserve immediately south of Childers Street and west of the South Kensington station subway (second option)
- Significant reconfiguration of the existing Sunbury line tracks and associated rail infrastructure for a distance of approximately 750 m (first option)
- Installation of new turnouts and supporting rail infrastructure
- Construction of elevated structure included rail bridge over Kensington Road and approach spans (second option)
- TBM retrieval.

A key construction site is proposed to be located at 1 – 39 Hobsons Road in Kensington to support activities at the western portal. This site would be used for site offices and facilities, laydown areas and materials and equipment storage.

During construction, Childers Street would be closed to traffic and used for construction activities. The car parks along Childers Street would be occupied during construction to provide room for additional construction traffic. The shared use path along the railway would also be occupied during construction.

The walking path in JJ Holland Park would be upgraded to be a shared use path at the commencement of construction to provide an alternative to the shared use path along Childers St that would be occupied during construction. There would be no construction activities for Melbourne Metro undertaken in JJ Holland Park.

The Concept Design assumes that construction techniques at this location would include groundwater management to mitigate inflow to excavations. Construction assumes closure of the eastern end of Childers Street and diversion of traffic around the area.

Further details on construction methodology and assumptions are provided in Section 6.6.

Figure 6-3 Precinct 2 – Western portal (Kensington) (Concept Design)

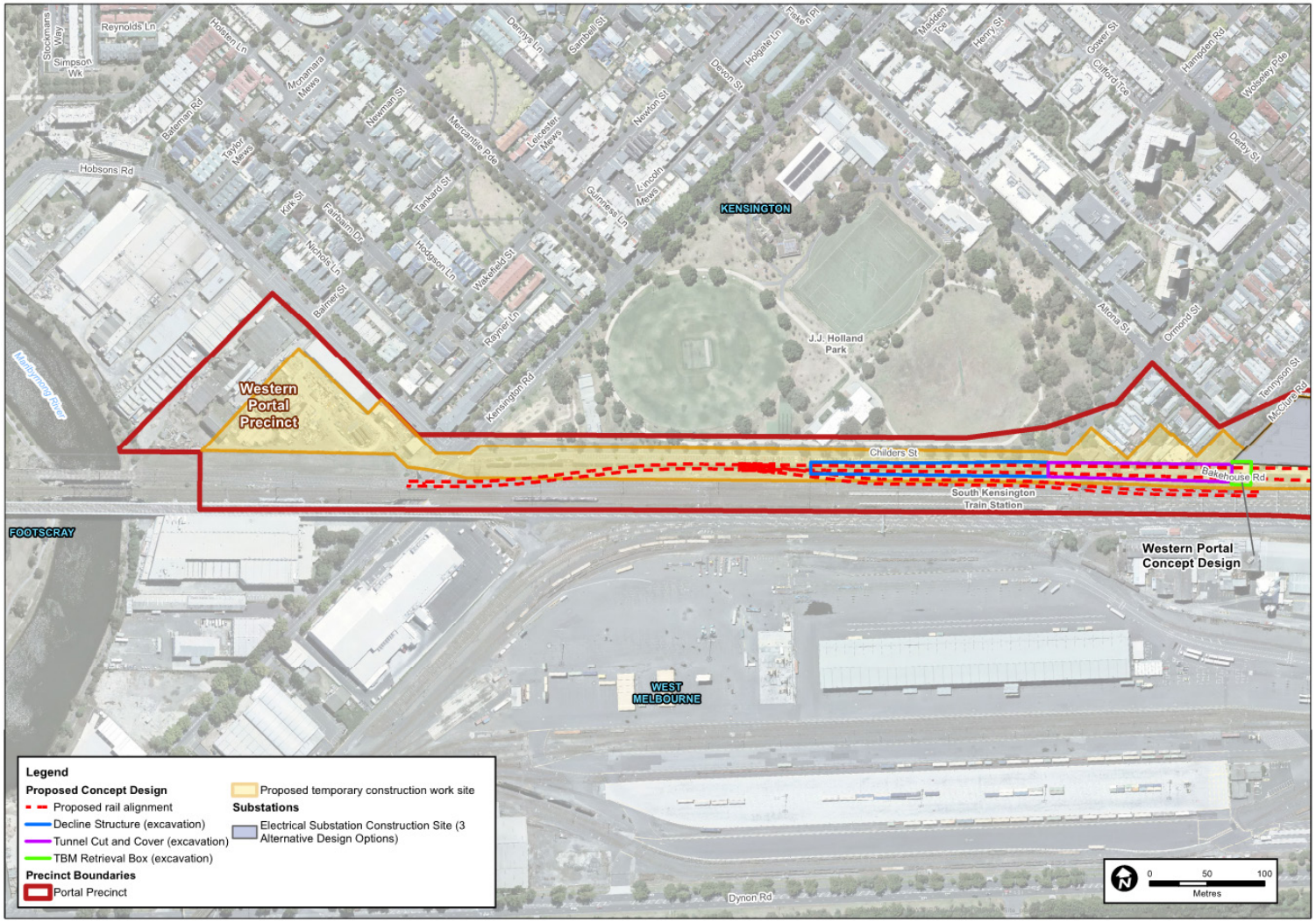
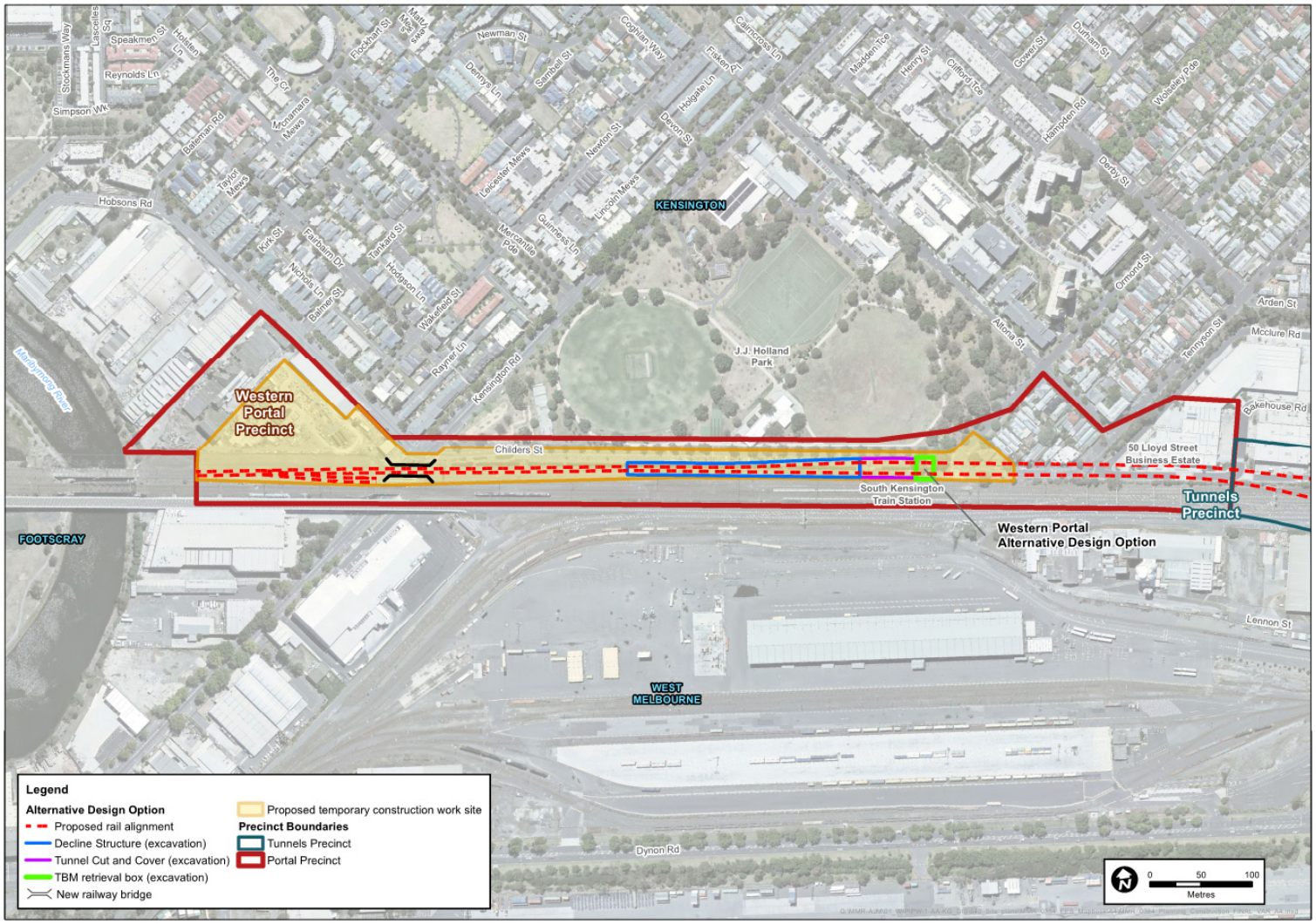


Figure 6-4 Precinct 2 – Western portal (Kensington) (alternative design option)



6.5.3 Precinct 3 – Arden station

The Arden station precinct is bound by CityLink to the west, Arden Street to the north, Dryburgh Street to the east and Dynon Road to the south. The precinct is characterised by wide streets, low rise development and a mix of land uses, including light and heavy industrial as well as residential. The precinct is dominated by a 14 ha industrial site owned and managed by VicTrack (a state-owned business and statutory owner of Victoria's railway land).

The area is expected to be the site of extensive urban renewal over the next 20 years.

Concept Design

Arden station would be the most westerly station on the proposed Melbourne Metro alignment. The station would be located underground on a diagonal alignment (from south-west to north-east) between Arden and Queensberry Streets, wholly within the government owned (VicTrack) industrial site. Key features of Arden station design include:

- An initial station entrance located on Laurens Street
- A second future entrance is proposed to be located approximately 120 m south of Arden Street, in line with a future southward extension of Fogarty Street
- Occupation of the publicly owned land would be required for both the station and Melbourne Metro construction work site.

Construction Activities

The station is proposed to be constructed using the cut and cover construction method (see Section 6.6.6). Main construction activities at the site would be:

- VicTrack land occupation and demolition
- Early works for the relocation and protection of utilities (refer to Section 6.5.10 for further details)
- Installation of temporary construction power cables from the West Melbourne Terminal Station to the Arden site (crossing Moonee Ponds Creek and rail reserve)
- Concrete batching plant and precast segment facility
- Removal of trees at the start of construction
- Station box excavation and TBM launch site

- Station structural works
- Station architectural, mechanical and electrical fit-out
- Track works and installation of rail systems.

In addition to the new station, the government owned land would be the key staging area and would include site offices and staff amenities, fabrication sheds, key storage areas and spoil extraction and handling facilities. Provision for flood water storage and a tunnel air ventilation and extraction plant would also be located on the site. TBM launch site support services would also be located on site such as a grouting plant, gantry crane, spoil handling system, water treatment plant and facilities to assemble the TBM. The site is expected to be required for the full construction period (approximately seven years).

The Concept Design assumes that construction techniques at this location would include groundwater management to mitigate inflow to excavations.

Further details on construction methodology and assumptions are provided in Section 6.6.

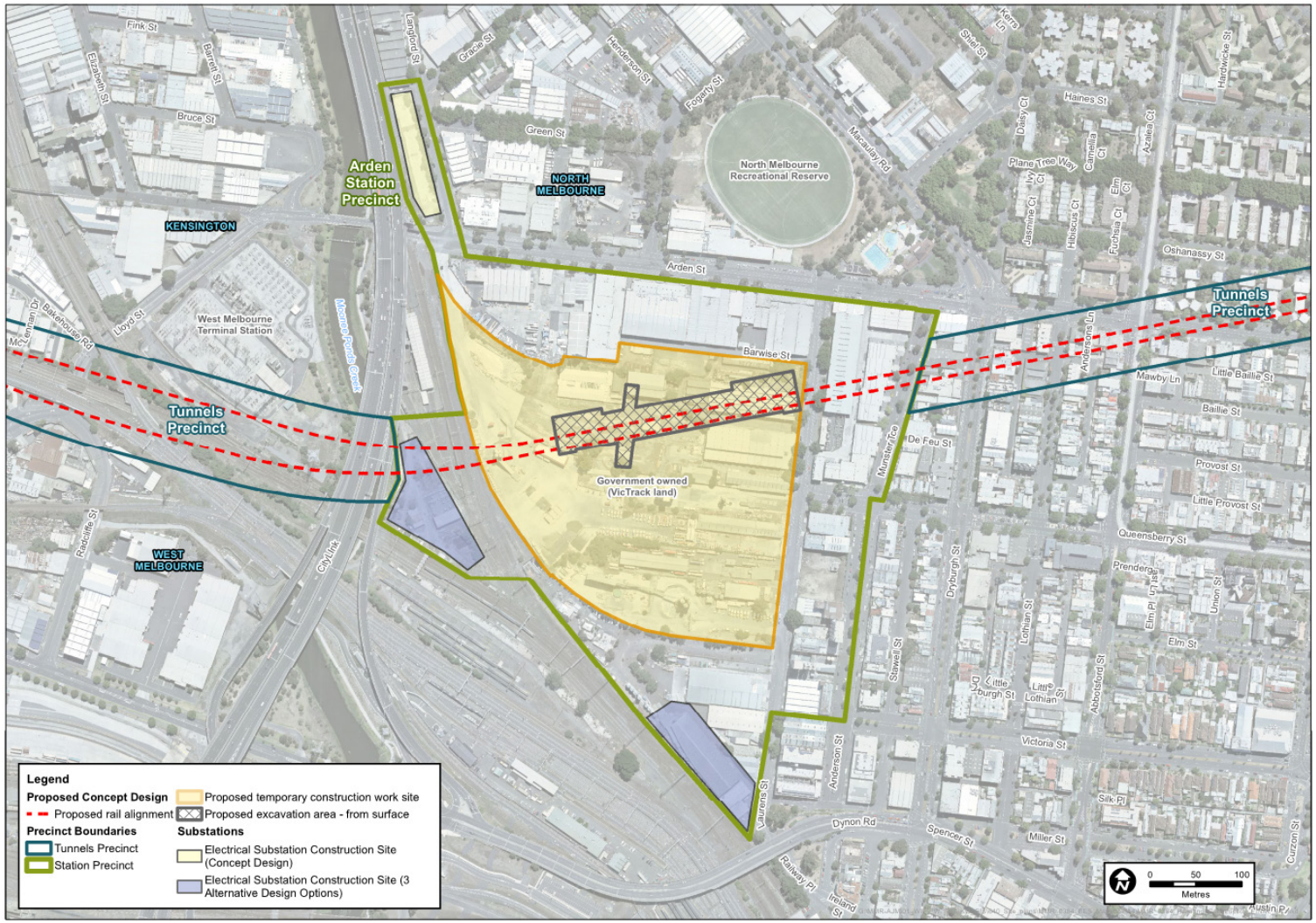
Substation

A substation would be required for Melbourne Metro to provide power for the operation of the tunnels and stations. Arden and the surrounding area has been chosen as the location for the substation due to its proximity to the West Melbourne Terminal Station and the availability of land. The substation would be required to step down the power being delivered by Ausnet at 66kV to 22kV, which could then be distributed throughout Melbourne Metro tunnels to provide operational traction and station power. This would involve permanent power cable routes from the West Melbourne Terminal Station to the substation (crossing Moonee Ponds Creek and rail reserve) and from the substation to the Arden site.

The Concept Design's proposed substation site is on publicly owned land to the north of Arden Street, between CityLink to the west and Langford Street to the east (refer to Figure 6-5). Alternatives considered in the EES for the substation location are:

- Co-location at Metro Trains Melbourne traction substation between CityLink and the Upfield line (refer to Figure 6-5)
- Southern section of the Arden station precinct, between rail to the west and Laurens Street to the east (refer to Figure 6-5)
- In the existing 50 Lloyd Street Business Estate at the eastern corner of Childers and Tennyson Streets (this option could only be used if the 50 Lloyd Street Business Estate location option is used as the site of the western portal (refer to Figure 6-3).

Figure 6-5 Precinct 3 – Arden station (Concept Design)



6.5.4 Precinct 4 – Parkville station

The Parkville station precinct is dominated by health and education uses, including the University of Melbourne, Royal Melbourne Hospital, Royal Women's Hospital, Royal Children's Hospital, the Peter Doherty Institute, the new Victorian Comprehensive Cancer Centre and other leading research and educational facilities. Many of these land uses feature high density development, while the residential area of Parkville to the north retains a strong heritage character and less intense development.

Royal Parade and Flemington Road are major historic boulevards that define the city structure north of the CBD. University Square (bordered by Grattan Street to the north, Barry Street to the west, Leicester Street to the east and Pelham Street to the south) provides landscaped open space and underground parking for the University of Melbourne.

Concept Design

Parkville station would be located under the Grattan Street road reserve, to the east of Royal Parade. The station's footprint would occupy the full width of Grattan Street and extend from the intersection of Grattan Street and Royal Parade to University Square. Key features of Parkville station design include:

- Two entrances located at the University of Melbourne at the corner of Royal Parade and north of Grattan Street (adjacent to Gatekeepers Cottage)
- One entrance located outside the Victorian Comprehensive Cancer Centre (on Grattan Street, near the corner of Royal Parade)
- Crossing to serve a new tram stop on Royal Parade and bus stops on Grattan Street
- Mechanical and electrical plant concentrated at the eastern end of the station and northern end of Barry Street.

Permanent changes to the road layouts at Parkville associated with the design include the narrowing of Grattan Street to one lane in each direction and two lanes in each direction on Royal Parade/Elizabeth Street (north of Haymarket roundabout).

Construction Activities

The station is proposed to be constructed using the cut and cover construction method (described in Section 6.6.6). Main construction activities at the site would be:

- Temporary property occupation and demolition (with landowner agreement)
- Early works for the relocation and protection of utilities (refer to Section 6.5.10 for details)

- Removal of trees at the start of construction and subsequent replacement of trees
- Tunnel excavations through the station box
- Station structural works and station entrance connections across Royal Parade
- Construction of underground pedestrian access between the station and Grattan Street (west of Royal Parade) outside the Victorian Comprehensive Cancer Centre
- Station architectural, mechanical and electrical fit-out
- Track works and installation of rail systems.

The cut and cover method would be used to construct the station box along Grattan Street east of Royal Parade. Either mined or cut and cover method could be adopted for the underground pedestrian connection across Royal Parade to the entrance located in front of the Victorian Comprehensive Cancer Centre.

Grattan Street would be closed to traffic between Royal Parade and Leicester Street during construction, with the potential for temporary closure between Royal Parade and Flemington Road. These closures would require the diversion of buses and constraining access to surrounding businesses during construction.

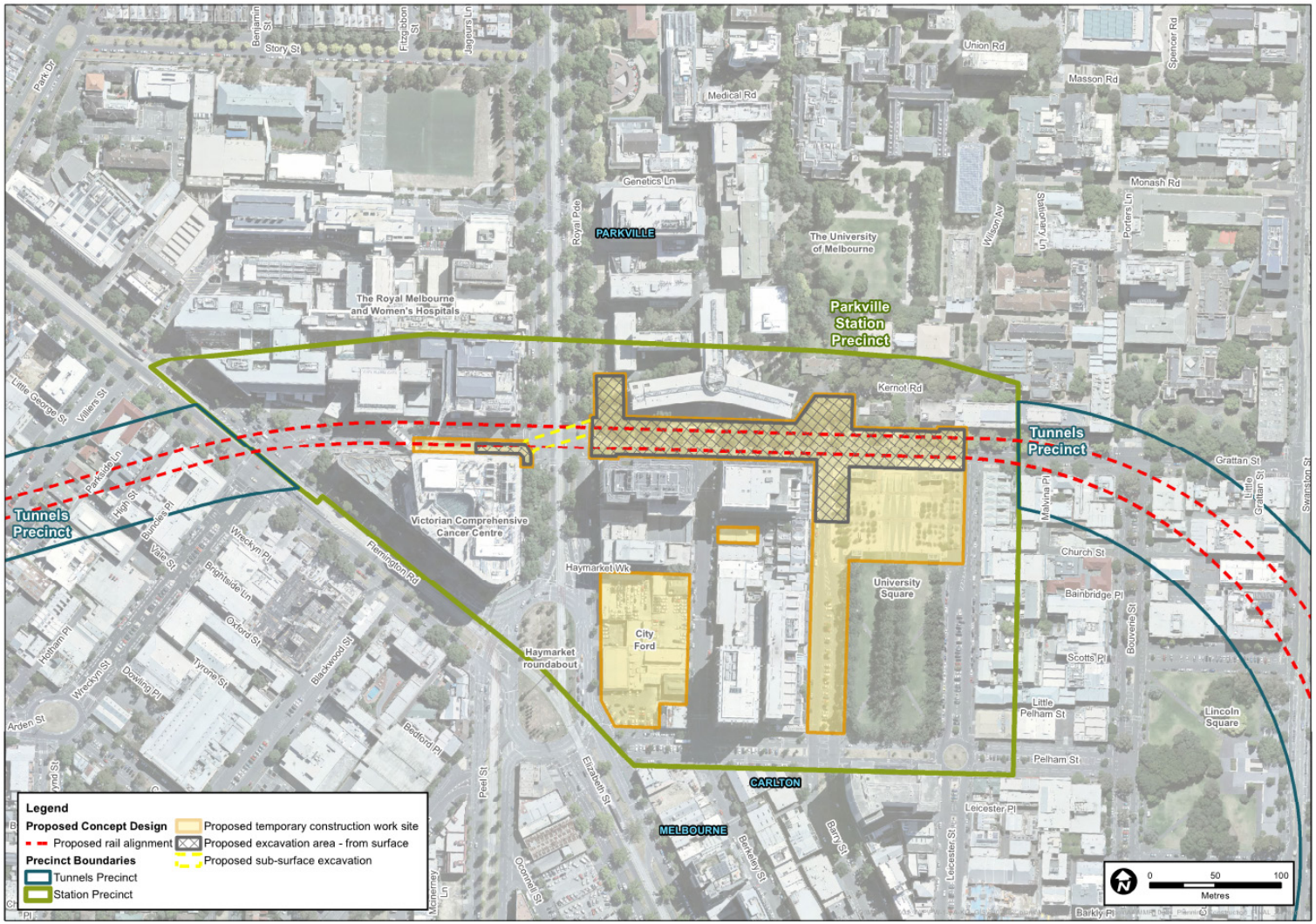
Pedestrian routes linking the precinct across Royal Parade and Grattan Street would be diverted and constrained. However, pedestrian access would be maintained to the university and health facilities adjacent to the construction area and within the precinct throughout the construction works.

Temporary occupation would be required of 750 Elizabeth Street and the northern section of University Square for use as a construction work site for a period of five years.

The Concept Design assumes that construction techniques at this location could include king posts and retaining walls (refer to Section 6.6.9 for details), measures to manage groundwater inflow to excavation areas, rock ripping, piling and, if required, blasting works.

Further details on construction methodology and assumptions are provided in Section 6.6.

Figure 6-6 Precinct 4 – Parkville station (Concept Design)



6.5.5 Precinct 5 – CBD North station

CBD North station would be located at the northern end of the Hoddle Grid that defines Melbourne's CBD. Initially a predominantly commercial and industrial precinct, the area around the proposed station is now characterised by a range of land uses including RMIT University, residential apartment towers, Melbourne Central Shopping Centre and Melbourne Central Station, the State Library and Melbourne City Baths. The area is highly developed and includes a diverse mix of modern and heritage buildings.

Swanston Street is the 'civic spine' of Melbourne and a high intensity tram corridor, with tram routes also running along La Trobe Street. The existing Melbourne Central Station, built as part of the City Loop, is located to the south of the precinct.

Concept Design

CBD North station would be located directly beneath Swanston Street, extending from La Trobe Street to north of Franklin Street. Key features of CBD North station design include:

- The station would be located immediately north of the existing City Loop tunnels (which run below La Trobe Street), with the two tunnels between CBD North and South stations passing under the City Loop tunnels
- A southern entrance would be located on La Trobe Street, with a direct pedestrian link to the existing Melbourne Central Station under La Trobe Street, surface connections to the existing tram lines running along Swanston and La Trobe Streets, and sufficient space to allow for provision of possible future over-site development opportunities
- The northern entrance is proposed to be located at Franklin Street to the east of Swanston Street and extending to Bowen Street, with the proposed permanent closure of Franklin Street east of Swanston Street
- Plant rooms would be located under Franklin Street (between Stewart and Bowen Streets) and A'Beckett Street, and at the main entrance at the corner of Swanston and La Trobe Streets
- Ventilation, fire egress and maintenance access would be provided in Franklin Street on the west side of Swanston Street
- Additional ventilation and maintenance access would be provided in A'Beckett Street between Stewart Street and Swanston Street.

Construction Activities

The station would be constructed under Swanston Street using the mined cavern construction method (described in Section 6.6.6). Main construction activities at the site would be:

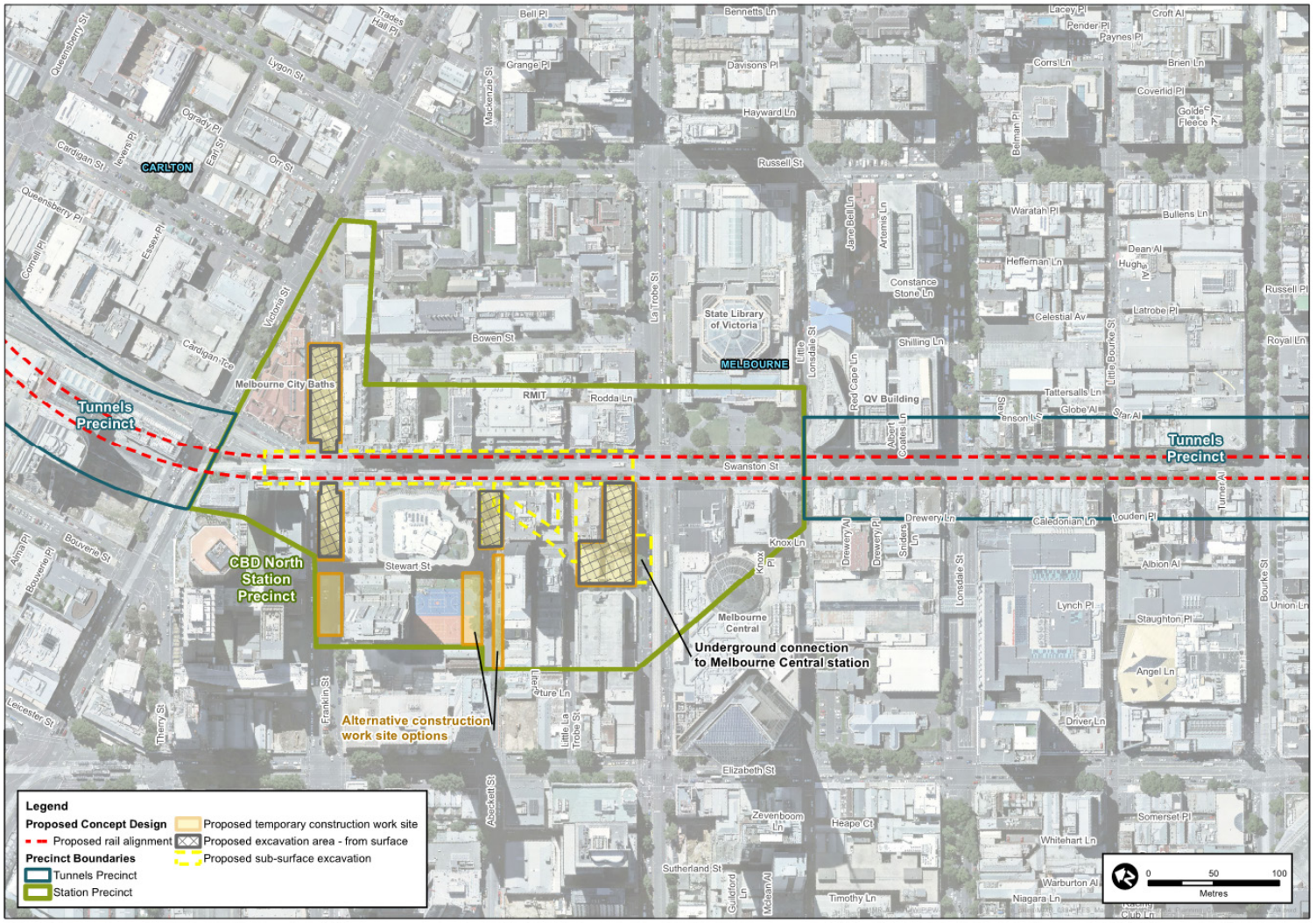
- Private property acquisition and demolition
- Early works for the relocation and protection of utilities and construction of Franklin Street and A'Beckett Street shafts (refer to Section 6.5.10 for details)
- Removal of trees at the start of construction and subsequent replacement of trees
- Cavern excavation of station tunnels
- Station structural works
- Construction of station entrances and connection to Melbourne Central Station
- Station architectural, mechanical and electrical fit-out
- Track works and installation of rail systems
- Restoration of construction work sites within the precinct.

Several areas adjacent to the station site are proposed for use as construction work sites, including either part of the RMIT basketball courts or A'Beckett Street. These sites would be located at the station entrance sites and, where these areas are not in existing road reserves, buildings would need to be demolished prior to construction commencing.

The Concept Design assumes that construction techniques at this location could include cavern and adit support, management of City Loop interface and management of groundwater inflow to excavation areas.

Further details on construction methodology and assumptions are provided in Section 6.6.

Figure 6-7 Precinct 5 – CBD North station (Concept Design)



6.5.6 Precinct 6 – CBD South station

This precinct is a highly urbanised and dense inner urban area, centred on the Swanston Street corridor between Collins and Flinders Streets. The area is located at the southern edge of the Hoddle Grid and is the site of several Melbourne landmarks and visitor destinations, including Federation Square, St Paul's Cathedral, City Square, Melbourne Town Hall, Young and Jackson Hotel and Flinders Street Station. These landmarks are supported by laneways such as Degraves Street, Centre Place and Hosier Place, which are lined with bars, cafes, restaurants and retail outlets.

Concept Design

CBD South station would be located at the southern edge of the CBD directly beneath Swanston Street, running between and partially under Flinders and Collins Streets. Key features of CBD South station design include:

- A southern entrance consisting of a pedestrian link running under Flinders Street directly into the main concourse at Flinders Street station, with another direct underground connection to Federation Square
- A northern entrance located at the northern end of the City Square, with the potential to add a second northern entrance on the west side of Swanston Street in 65 and 67 Swanston Street
- Sufficient provision made to enable later development over the station connection between Flinders Street and CBD South station, with new connections to the inner city laneway network to the west and to Flinders Street Station
- Ventilation located under the southern entrance and under the northern entrance at City Square
- Emergency egress provided at the northern end of the station box via a mined cavern to the City Square entry box.

Construction Activities

The station would be constructed under Swanston Street using the mined cavern construction method (described in Section 6.6.6). The main construction activities at the site would be:

- Private property acquisition and demolition
- Early works for the relocation and protection of utilities, and construction within City Square (refer to Section 6.5.10 for details)
- Relocation and protection of the Burke and Wills statue
- Removal of trees at the start of construction and subsequent replacement of trees

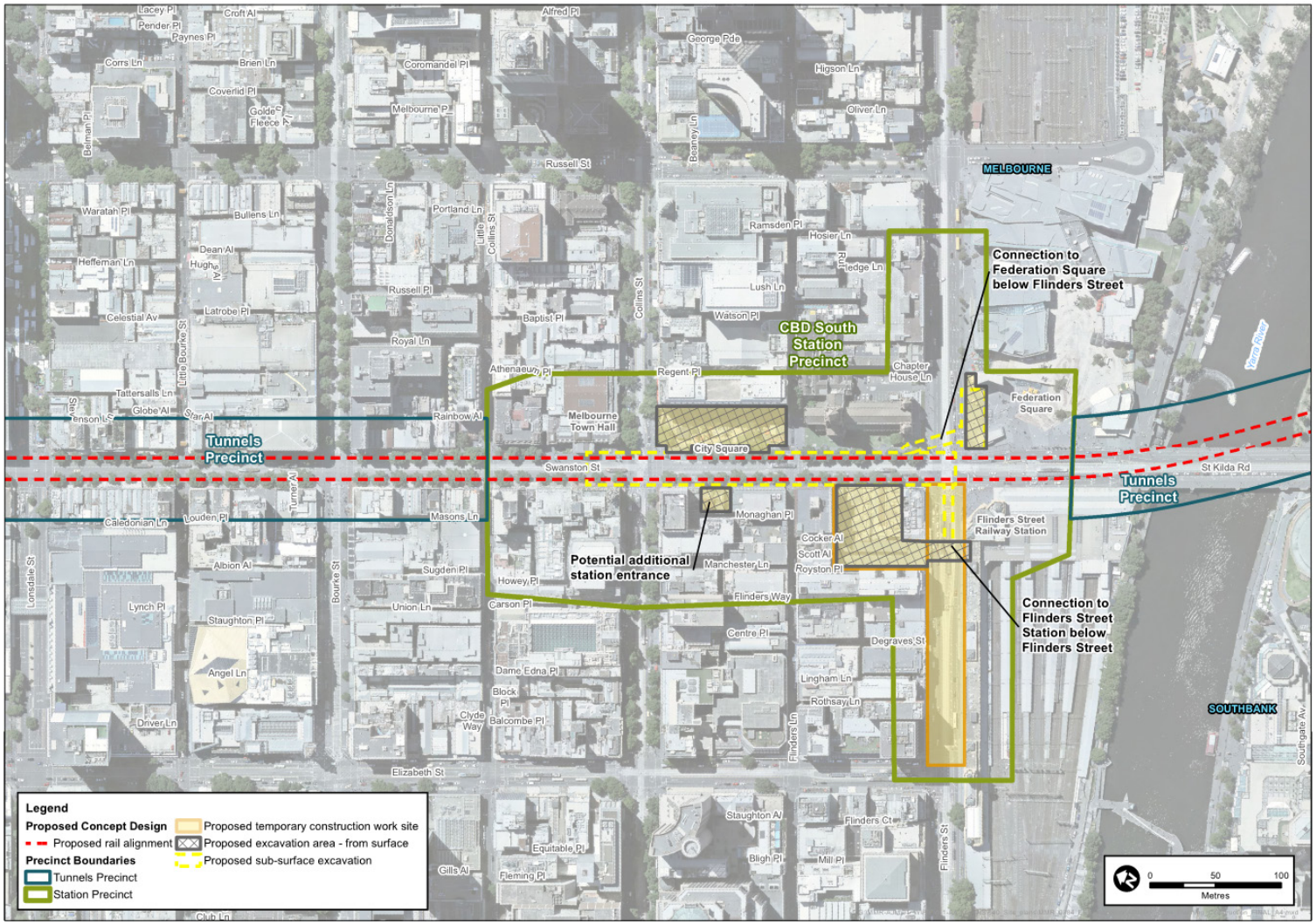
- Construction of station entrances and connections to Flinders Street Station and Federation Square
- Station structural works
- Station architectural, mechanical and electrical fit-out
- Track works and installation of rail systems
- Restoration of Swanston Street and City Square.

Construction sites are proposed to be located at the station entries in the City Square, Federation Square and the southern entrance fronting Swanston Street.

The Concept Design assumes that construction techniques at this location could include cavern and adit support, and groundwater management to mitigate inflow to excavations through retaining walls, ground water recharge and potential grouting. Techniques could also include rock removal and rockbreaking, scheduling and buffering of excavation near commercial buildings, and specific scheduling or sequencing of works near residential buildings.

Further details on construction methodology and assumptions are provided in Section 6.6.

Figure 6-8 Precinct 6 – CBD South station (Concept Design)



6.5.7 Precinct 7 – Domain station

This precinct is dominated by parks and gardens and the Shrine of Remembrance along the east side of St Kilda Road north of Domain Road, offices and residential apartments along the west side of St Kilda Road, and Melbourne Grammar School and commercial premises along the east side of St Kilda Road to the south of Domain Road.

Concept Design

The new Domain station would be located under St Kilda Road, adjacent to Albert and Domain Roads. Key features of Domain station design include:

- The station box would be positioned so that no private land acquisition is required
- Three station entrances would be located:
  - On the east side of St Kilda Road
  - In the Domain tram interchange in the centre of St Kilda Road
  - On the west side of St Kilda Road in the reserve on the corner of Albert Road and St Kilda Road.

Construction Activities

The station is proposed to be constructed using the cut and cover construction method (described in Section 6.6.6). Main construction activities at the site would be:

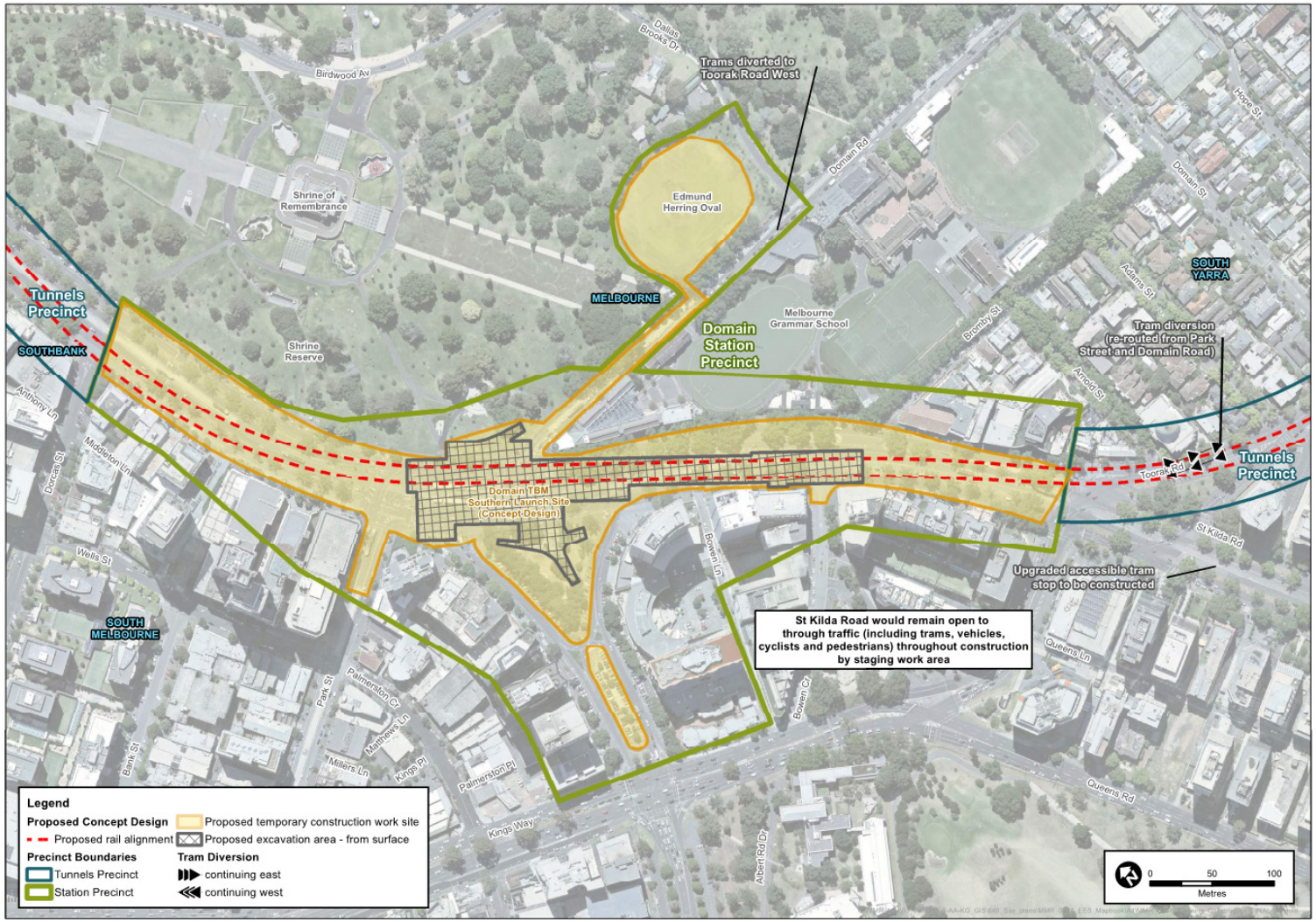
- Early works for the relocation and protection of utilities (refer to Section 6.5.10 for further details)
- Storage, relocation and protection of the South African Soldiers Memorial located within the Albert Road Reserve (refer to Section 6.5.10 for details)
- Removal of trees at the start of construction and subsequent replacement of trees
- Relocation and removal of traffic islands, trams stops and shelters and car parking spaces along St Kilda Road, including the installation and diversion of tram services to Toorak Road to connect with St Kilda Road, with the closure of Domain Road being required during construction
- Station structural works
- Station architectural, mechanical and electrical fit-out
- Track works and installation of rail systems
- Restoration of St Kilda Road (including tram stops) and parklands.

As a minimum, one tram track, one bike lane and one traffic lane in each direction would be provided along St Kilda Road during construction.

Construction work sites would be required on each side of St Kilda Road at Edmund Herring Oval, the Albert Road Reserve and within the St Kilda Road construction footprint. The TBM launch sites would be located at either Domain only or Domain station (within St Kilda Road) and within Fawkner Park.

The Concept Design assumes that construction techniques at this location could include groundwater management through diaphragm walls, and specific scheduling, buffering and management of rockbreaking works near sensitive receptors. Further details on construction methodology and assumptions are provided in Section 6.6.

Figure 6-9 Precinct 7 – Domain station (Concept Design)



6.5.8 Precinct 8 – Eastern Portal (South Yarra)

This precinct is highly urbanised and comprises extensive mixed use development and a diverse range of housing types, from low density detached housing to large residential apartment blocks. The existing railway line is bordered by this residential development and the South Yarra Siding Reserve. The area is also adjacent to one of Melbourne's busiest retail and entertainment precincts, centred on Toorak Road and Chapel Street.

Concept Design

The eastern portal precinct would connect the two tunnels to the existing Dandenong rail corridor just west of Chapel Street. The portal would include the approach to the tunnels and the tunnel works that connect to the tunnel precinct (Precinct 1). The proposed portal alignment and design includes:

- Cut and cover structure (from under the Sandringham lines, Frankston lines and a freight and regional line) into a decline structure (open to air) to bring the proposed Melbourne Metro tracks to the same vertical level as the existing rail corridor
- Turnouts at the tie-in to the Dandenong rail corridor to allow freight and regional services to travel along the existing surface city-bound tracks via Richmond station, while Dandenong rail corridor services access Melbourne Metro underground alignment
- A TBM retrieval box (incorporating other plant) located in the rail reserve adjacent and to the east of Osborne Street
- Permanent realignment of the existing Dandenong and Frankston line tracks between Toorak Road and Chapel Street
- A tunnel ventilation shaft, emergency access shaft and an underground substation located at the TBM retrieval box.

Construction Activities

Main construction activities at the site would be:

- Private property acquisition and demolition and temporary occupation
- Early works for the relocation and protection of utilities (refer to Section 6.5.10 for details)
- Removal of trees at the start of construction and subsequent replacement of trees
- Cut and cover excavation of the tunnel box
- Widening of the existing rail corridor and construction of retaining walls

- Construction of ventilation shaft, emergency access shaft and substation in Osborne Street Reserve
- Retrieval of the TBMs from Osborne Street and the adjoining rail reserve
- Track works and installation of rail systems
- Construction of a vehicular access bridge from Osborne Street for construction vehicles, to be converted to a pedestrian bridge post-construction
- Removal, reinstatement and upgrading of William Street bridge, South Yarra Siding Reserve, Osborne Street Reserve and Lovers Walk.

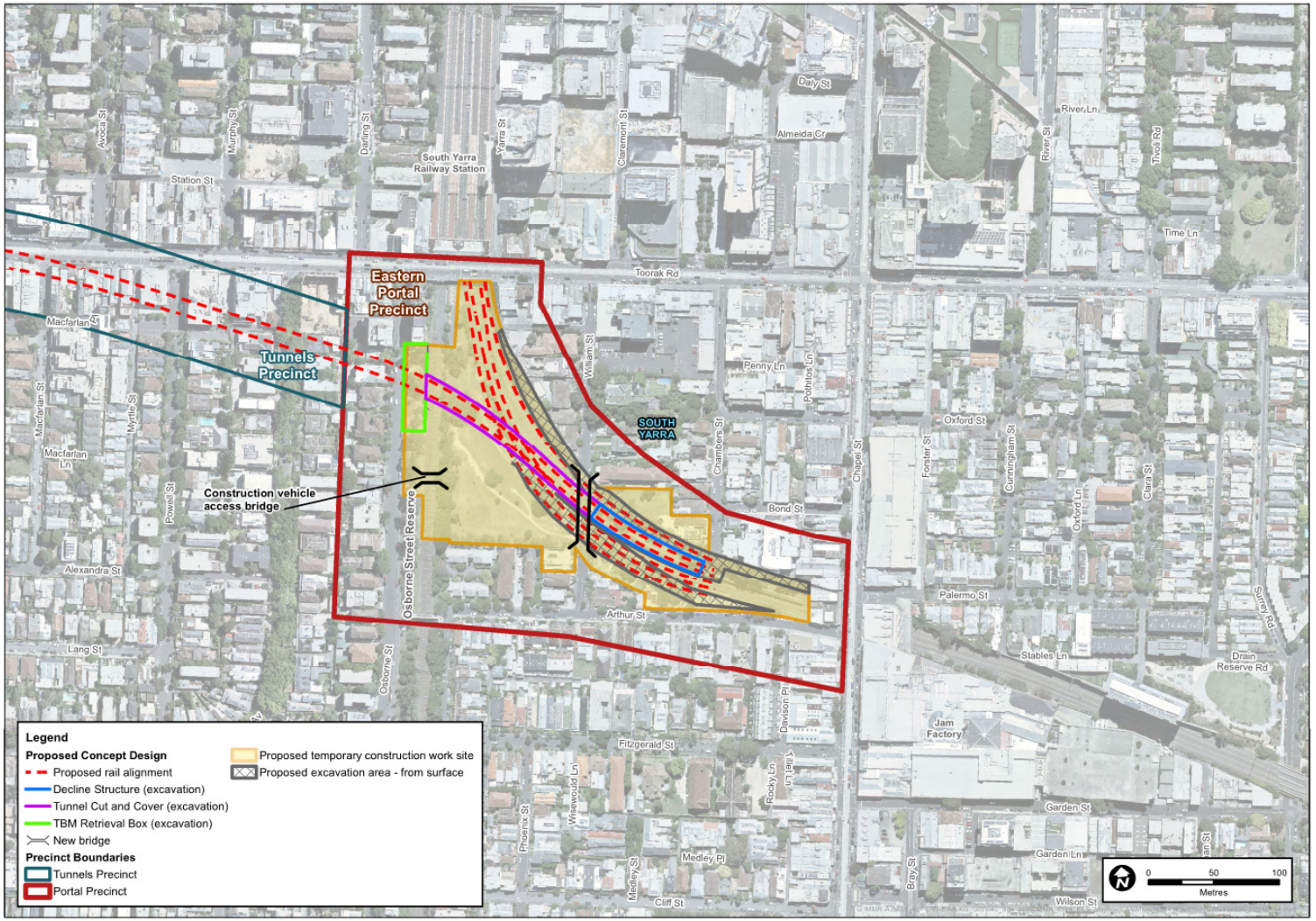
Traffic movements would likely be via Toorak Road and some connecting residential streets. The South Yarra Siding Reserve and Osborne Street Reserve would be occupied as key construction work sites, housing site offices, amenities, materials laydown and equipment storage.

A number of track occupations (access to an operating rail line) would be required to connect Melbourne Metro to the Dandenong rail corridor. These occupations would potentially disrupt services on parts of the rail network.

The Concept Design assumes that construction techniques at this location could include secant piles and soil nail walls.

Further details on construction methodology and assumptions are provided in Section 6.6.

Figure 6-10 Precinct 8 – Eastern portal (South Yarra) (Concept Design)



6.5.9 Precinct 9 – Western Turnback

Operations of the new Melbourne Metro line would involve turning back some trains early (referred to as a 'turnback') on the Sunbury line to provide the flexibility to run back towards the CBD to optimise the efficient service of the Melbourne Metro corridor. The proposed western turnback for Melbourne Metro would be located at West Footscray within the existing rail reserve.

Concept Design

The proposed design for the West Footscray turnback includes:

- Realignment of regional, suburban and freight lines
- Construction of new track and turnouts
- Construction of a third passenger platform at West Footscray station and alterations to the existing concourse.

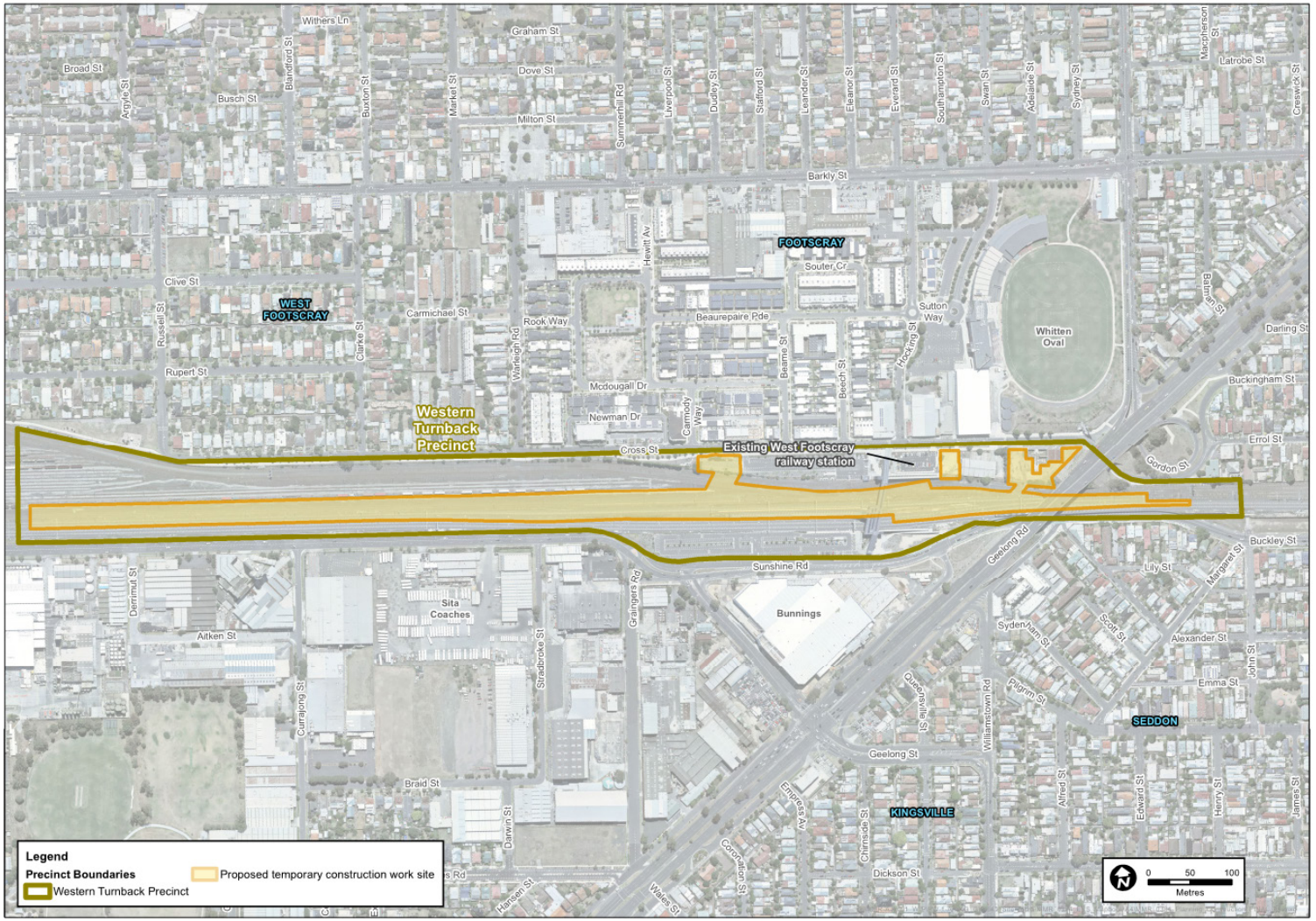
Construction Activities

The proposed works would be located within publicly owned (VicTrack) land. The works location is adjacent to a commercial and industrial area to the south and residential areas and recreation facilities (including the Whitten Oval) to the north.

No land acquisition would be required. However, approximately 26 car parks and additional VicTrack land adjacent to railways would be occupied during the construction phase. It is assumed that there would not be a direct impact on the former substation site located within VicTrack property and construction area.

Further details on construction methodology and assumptions are provided in Section 6.6.

Figure 6-11 Precinct 9 – Western turnback (Concept Design)



6.5.10 Early works

Early works would be undertaken prior to the main construction works and would include:

- Third party services – such as the relocation and protection of services, removal and if possible relocation of trees, and relocation of monuments
- Transport diversions – for public transport and active transport routes and facilities, and for other traffic such as emergency vehicles, delivery vehicles and cars
- Site preparation – including access arrangements (such as road upgrades and temporary relocation of car parking), new assets (such as permanent high voltage power supply for rail) and building demolitions
- Shaft preparation – excavation works and shaft construction at CBD stations.

Some of these works would be carried out under a Managing Contractor arrangement; others would be carried out by the main project contractor, Yarra Trams or utility service providers. These works would comply with the recommended Environmental Performance Requirements developed for Melbourne Metro.

These early works are distinct from the specified 'enabling works' that are exempt from assessment as part of the EES by virtue of the Minister for Planning's declaration (see Section 1.3.1).

The table below lists the early works proposed within and surrounding each precinct.

Table 6–4 Summary of key early works activities

Precinct	Proposed early works
Western portal (Kensington)	Service relocation and/or protection including: • Electricity, including relocation of high voltage transmission towers • Gas, including high pressure Dandenong-West Melbourne transmission main • Sewer • Telecommunication conduits • Water mains • Stormwater drain.
Arden	Service relocation and/or protection including: • Electricity • Telecommunications • Stormwater drains • Demolition of buildings within the Arden VicTrack site.

Precinct	Proposed early works
Parkville	Service relocation and/or protection including: • Electricity conduits • Gas mains • Telecommunications conduits • Water mains • Stormwater drain • Sewers.
CBD North	Service relocation and/or protection including: • Electricity conduits • Gas mains • Sewers • Telecommunications conduits • Water mains • Stormwater drains. Construction of shafts at Franklin Street and A'Beckett Street. Demolition of buildings located at station entrances.
CBD South	Service relocation and/or protection including: • Electricity conduit • Gas mains • Sewers • Telecommunications conduits • Water mains • Stormwater drains. Demolition and shaft construction at City Square, potentially including relocation and protection of the Burke and Wills statue.
Domain	Service relocation and/or protection including: • Sewers • Telecommunications conduit • Water main • Stormwater • Electricity. Storage, relocation and protection of the South African Soldiers Memorial located within the Albert Road Reserve. Diversion of tram services along Toorak Road to connect with St Kilda Road.
Eastern portal (South Yarra)	Service relocation and/or protection including: • Electricity conduits • Gas mains • Telecommunications conduit • Water main.

6.6 Construction Methodology

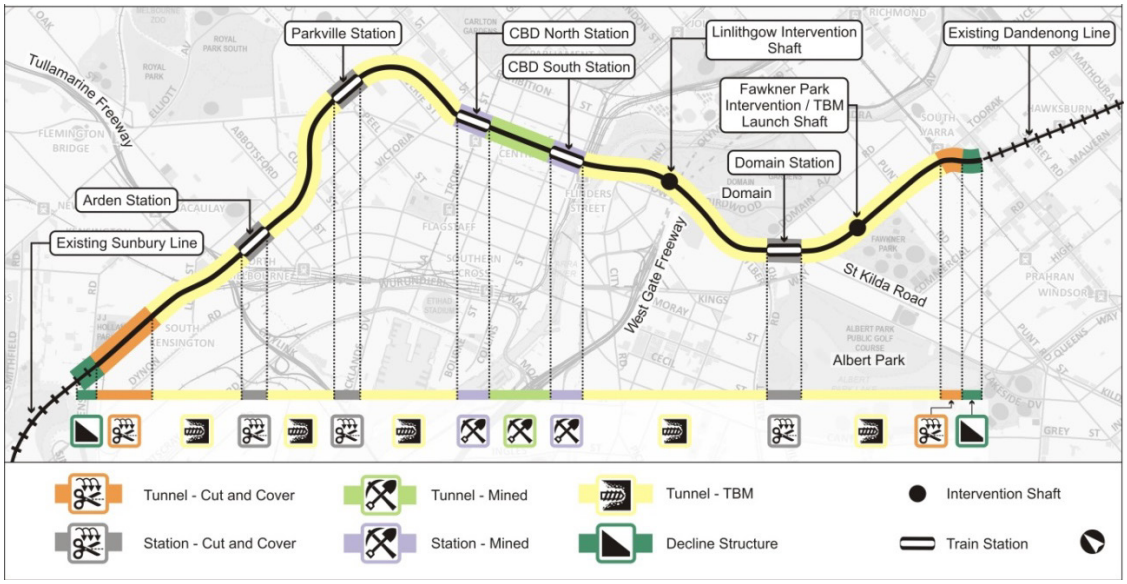
The project wide construction methods and program outlined in this section provide the basis for preparing the EES and assessing potential impacts of Melbourne Metro. The construction contractors for Melbourne Metro would have flexibility to adopt alternative construction methods and practices provided these still meet the approved Environmental Performance Requirements and comply with the relevant statutory approvals.

Project construction can be categorised broadly into the construction of stations, tunnels and shafts, and portals. Each would require different construction methods, illustrated in the figure below.

The main construction activities are the civil and structural works normally associated with a major rail tunnel project, including:

- General earthworks – top soil removal, clearing and grubbing vegetation
- Relocation, adjustment or installation of new utility services
- Retaining walls
- Advanced ground treatment to stabilise soils
- Tunnel excavation and portal construction
- Station and platform construction
- Temporary stockpile and management of spoil
- Construction of cross-passages, ventilation structures and access shafts
- Installation of drainage and water quality treatments
- Tunnel and station fit-out.

Figure 6-12 Melbourne Metro proposed construction methods



6.6.1 Construction Assumptions

Key assumptions regarding project wide construction activities are summarised in Table 6–5.

Table 6–5 Melbourne Metro project-wide assumptions

Project aspect	Assumptions
General works	• A large on-site workforce would be engaged during the construction period, requiring access to and from key work areas. As most of the key construction work sites are easily accessible by public transport, it is expected that parking provisions could be minimised, particularly in the CBD • A materials laydown area would be required at each construction site (that is, construction methods are not relying entirely on a just-in-time logistics strategy) • Each construction work site would contain water treatment and storage facilities • Foot traffic and cycling connectivity would be maintained during construction wherever possible • Each station would require access shafts to be kept open for the duration of construction for spoil removal and delivery of construction materials and fit-out equipment • Station construction would be timed to coordinate with either the launch or retrieval of the TBMs for Arden, Domain and Parkville stations • Project specific agreements would be in place with the rail operator franchisee to ensure track occupations are undertaken as required • Temporary and/or permanent ground support using stabilisation methods such as rock bolts, anchors or soil nails may be required during the project to provide earth retaining systems or support to ensure safe and

Project aspect	Assumptions
	robust underground excavations. Rock bolts, anchors and soil nails typically comprise a steel anchor/strand surrounded by grout with the former tensioned using chemical or mechanical methods
	• Construction operations would comply with the noise, surface water, groundwater, waste management, contaminated soil and air quality requirements of the *Environment Protection Act 1970* and all relevant guidelines • Protection of heritage values within and surrounding the construction would be required, unless the loss has been determined to be minor or acceptable in the context of a major transport infrastructure project. Measures include protection in-situ of and temporary or permanent relocation (such as South African Soldiers Memorial and Burke and Wills statue) • Monitoring regimes would be put in place to measure settlement, dust, groundwater, water quality, noise and vibration in line with regulatory requirements and best construction practice and relative to the approved Environmental Performance Requirements • Access to businesses and residences at station and portal construction locations would be maintained • Advanced ground treatment (grouting works) expected to occur from surface in some areas, as required • Closed face and pressurised TBMs would be used and tunnel lining installed to create tanked (sealed) tunnels • Tunnels and stations are to be constructed as undrained structures • Construction operations would contribute to achievement of the ISCA 'Excellent' rating, for example through use of renewable energy and reduction of Portland cement content • Hardstand construction laydown areas would be preferred in most locations • At the main construction site at Arden, access to the site outside Normal Working Hours would be directly to/from Arden Street only, and construction traffic would avoid non-arterial roads as far as practicable outside Normal Working Hours, as defined by EPA Noise Control Guidelines, Publication 1254
Precinct specific works	The nature of this long, linear project means that construction would pass through different ground conditions and need to manage a range of potential social and environmental issues in various locations. This gives rise to some precinct-specific construction assumptions outlined in Section 6.5. The recommended Environmental Performance Requirements set the parameters which must be achieved in any event, if the construction contractor wishes to use a different construction methodology.

6.6.2 Choice of Construction Methodologies

Various construction methodologies have been considered for each of the major project components. These methodologies are assessed against the following general criteria:

- Minimise potential impacts
- Minimise construction cost

- Minimise construction duration, particularly those items that contribute to the project critical path or activities that contribute to impacts on stakeholders
- Minimise the interfaces between different types of construction performed under different contracts or by different subcontractors
- Allow sufficient time for interface between construction activities to reduce the risk that one element is delayed due to the late delivery of an interface activity.

The construction of the tunnels and stations and the interfaces between them are a major focus of the choice of construction methodologies. Tunnels are constructed using specialised equipment with dedicated personnel, while the station construction techniques are more conventional and can be executed by workforces from the general construction industry. Typically, interfaces occur at the TBM launch locations, at stations that receive and relaunch TBMs or retrieval of the TBMs at the end of their drives.

This section briefly describes why key construction methodologies have been proposed for Melbourne Metro that have been assessed in this EES.

Tunnel Construction

Possible tunnel construction methods include cut and cover, mined techniques with temporary supports followed by a permanent in-situ lining or TBMs where the TBM shield provides the temporary support with the permanent lining erected from segments within the TBM shield.

Tunnel Portals (Entrances)

Cut and cover has been proposed for the tunnel portals as there is insufficient cover to the ground surface to use other techniques.

Main Tunnel Drives

Cut and cover construction is not appropriate for the main tunnel drives due to the excessive cost and disruption to properties, services and infrastructure that this technique would cause. Long stretches of cut and cover construction for tunnels would generally only be considered for shallow tunnels in less developed areas.

Modern TBM equipment is capable of handling the ground and ground water conditions expected along the tunnel alignment. Therefore, TBM tunnelling has been chosen for the main drives, as it is the most economical tunnelling technique available with the lowest risk profile. Refer to Section 6.6.7 for further details on tunnel construction.

Yarra River Crossing

For the Yarra River crossing, two other tunnelling techniques were considered in addition to TBM tunnelling. The three options considered were:

- Cofferdam – Construction of a twin-tunnel in-situ cast concrete structure undertaken from within a 'dry' cofferdam combined with mined tunnels under Flinders Street Station, the Princes Bridge, the vaults of the North Bank and Federation Square. This would require underpinning of four piles supporting 'Pier 9' at Federation Square
- Immersed Tube Tunnel (ITT) – Consisting of four prefabricated steel hull or reinforced concrete units and an in-situ make up piece under the Yarra River. Requires an access shaft on each bank of the Yarra River combined with mined tunnels under Flinders Street Station, the Princes Bridge, the vaults of the North bank and Federation Square. Requires underpinning of four piles supporting 'Pier 9' at Federation Square
- Tunnel Boring Machine (TBM) – Driven tunnels using TBMs in closed mode operation including the tunnels to CBD South station. The horizontal alignment is modified from that of the Cofferdam and the ITT to avoid underpinning of 'Pier 9' piles and to take advantage of full cover of the upper level of basalt over both of the tunnel drives. The vertical alignment is deeper than the Cofferdam or ITT to take advantage of the preferred tunnelling mediums below the Yarra River bed.

TBM construction would be used for crossing beneath the Yarra River and no alternative design options have been allowed for in this EES. The Cofferdam and ITT options are more disruptive, more expensive and expose the project to greater risk than the TBM option.

CBD Tunnel Construction

The choice of TBM tunnelling for the Yarra River crossing, with its deeper alignment, allowed a deeper station to be considered for CBD South and the possibility of cavern construction to avoid critical existing services and surface disruption. This led to CBD North also being lowered to allow cavern construction. Further discussion on the relative merits of construction techniques for the CBD stations is provided in the following section.

Previously, a shallower alignment between CBD North and South precluded the use of TBMs between the stations as the ground cover was insufficient. The tunnelling construction techniques available were cut and cover with significant surface disruption, or mining techniques.

With the deeper alignment it is possible to use TBMs between the stations. However, mining techniques have been proposed as the tunnels could be constructed in parallel with the station cavern construction. This would improve the overall program by not having to transfer the TBMs through the CBD North station cavern, which would delay the installation of internal structures and fit out of the station.

TBM Launch Sites

The options considered for the TBM launch sites included the portals and each of the station locations. The available land at both the eastern and western portals is insufficient to support tunnel construction without major land acquisition and impacts on the local community. The Parkville, CBD North and CBD South station sites were also ruled out as TBM launch sites due to their lack of working space and the impacts on surrounding stakeholders.

The Arden site was chosen as the TBM launch site for the western tunnels. The existing industrial usage of land surrounding Arden station and the large land area that has been made available with the expiry of VicTrack leases in the area makes Arden an appropriate site. There is also sufficient land available at Arden for project support facilities such as a precast segment manufacturing facility and dedicated project concrete batching plant.

For the eastern tunnels, the Domain site (located within the St Kilda Road reserve, and the nearby Edmund Herring Oval) provides sufficient land to launch and support TBM drives from either end of the station box. The nearby Fawkner Park site could also be used to launch and support TBMs, should this be required. Refer to Section 6.5.1 for description of the two alternative TBM launch sites being considered for the eastern tunnels.

TBM Interface with Stations

At Arden, the ends of the station box would be used as TBM launch shafts. The construction of the ends of the station box would be prioritised to ensure the TBM launches are not delayed by station construction. The station construction can then proceed in parallel with the tunnel construction with sufficient float in the program allowed to reduce the risk of slower than expected tunnelling delaying the completion of the station.

The TBMs used to construct the tunnels between Arden and CBD North would be walked through the Parkville station enroute to CBD North. A ‘soft eye’ would be constructed for each of the tunnels in the station end walls to facilitate breakthrough of the TBMs at the western end of the station box and the subsequent relaunch at the eastern end. A ‘soft eye’ is an area created to allow the TBM to safely enter an open cavern. A ‘soft eye’ is typically created with fibreglass reinforcement in the concrete elements so it is easily broken up by the TBMs.

Parkville station is likely to be constructed using the bottom up technique to ensure the station box is fully excavated before the earliest possible TBM arrival date. The station is designed with bell ends. The bell ends are a slight widening and deepening of the station box to receive the TBMs before the main body of the TBM is slid to the other end of the box on purpose built steel cradles and greased concreted surfaces.

At CBD North, the TBMs would break into ‘soft eyes’ in the northern end wall of the station cavern. The TBMs would be dismantled and taken back to Arden via the completed tunnel to avoid the need for a shaft in Swanston Street. This would minimise the impact of tunnel construction on the station and reduces the risk of delays to the station should the tunnels take longer than expected. The methodology for the TBMs driven from Domain to CBD South is the same.

Domain station is similar to Arden although the tunnels between Domain and the eastern portal could be driven to Domain from Fawkner Park where they would be received at Domain rather than launched. Either way the impacts on construction of Domain station are manageable.

Portal and Station Construction

The eastern and western portals are proposed to be constructed using a cut and cover technique. Further details on portal construction are provided in Section 6.6.8.

The CBD stations for the Concept Design have been designed to be constructed as caverns (for further details on station cavern construction refer to Section 6.6.6). The alignment would be deep enough to provide sufficient cover for cavern construction, removing the need to open up Swanston Street. The trams can be retained and impacts on City businesses are significantly reduced as compared to shallow station construction using the cut and cover technique. There is also a significant reduction in critical utility services that need to be relocated. Cavern construction for the CBD stations also provides an opportunity to improve the overall construction program for the project.

The stations at Arden, Parkville and Domain are proposed to be constructed using the cut and cover method. Further details on cut and cover construction of stations are provided in Section 6.6.6.

The top down method is preferred in extremely poor ground conditions due to the additional stiffness the permanent roof slab can provide to help minimise ground movement. Arden station is in somewhat poorer ground relative to the other stations but its location in an industrial area clear of sensitive structures means that ground settlements can be adequately controlled should the bottom up method be used.

The impacts of both methods are similar as the construction elements are the same however the construction sequence varies. Noise can be controlled to allow work overnight for either method with the use of acoustic sheds. For top down the sheds are constructed on the permanent roof while for bottom up a temporary decking is used to control noise, with access holes located within the acoustic sheds.

A cut and cover construction technique has been adopted for the Concept Design at Domain and Parkville for a number of reasons relating to location constraints (limited areas suitable for shaft construction), ground conditions, program implications, disruption and cost. If a contractor can address the factors which have influenced the selection of cut and cover construction technique for the Concept Design and comply with the Environmental Performance Requirements, then cavern construction of these two stations could be feasible.

The reconfiguration of St Kilda Road is required to facilitate the new station entrance and station infrastructure in the centre of St Kilda Road to provide a tram interchange, which is a key feature of Domain station. The Domain station box is also required to be the main TBM launch site for the eastern section of the project, thereby reducing or eliminating the need for a site at Fawkner Park.

At Arden, the ground conditions do not suit cavern construction. An above ground station could be possible for Arden; however, this option was precluded by the disruption to the existing Upfield, Sunbury, Craigieburn and Werribee lines of having additional tracks constructed within the operational rail reserve at surface level. Further, an above ground station at Arden would have negative impact on future development of the Arden site. Consequently, cut and cover has been adopted for Arden station.

6.6.3 Main Construction Work Sites

Construction of Melbourne Metro would require a number of construction work sites along the proposed alignment.

Construction work sites would vary in size and scale depending upon work site requirements. Construction work sites for key tunnelling activities would support driven tunnelling activities (including spoil management) and construction requirements such as offices, worker car parking, access and storage. Construction work sites for stations and associated works would include sufficient area for surface construction works and basic construction facilities such as offices, access and storage.

Public access to work areas and construction work sites would be restricted. Appropriate fencing and screening would be provided for safety and to minimise visual impact and nuisances such as noise and dust for nearby communities.

The main construction work sites proposed for Melbourne Metro are listed in the table below.

Table 6–6 Main Melbourne Metro construction work sites

Precinct	Main construction work sites
1 – Tunnels	TBM launch sites located at Arden and Domain. Option for additional TBM launch from Fawkner Park in addition to Domain. Emergency access shafts may also be required in Fawkner Park and Linlithgow Avenue.
2 – Western portal	A site located on 1-39 Hobsons Road in Kensington for the western portal.
3 – Arden station	Approximately 10 ha of a 14 ha site at Arden to be used by the contractor for logistics, materials delivery, a tunnel segment casting facility, TBM launch, dedicated concrete batching plant and temporary storage of spoil.
4 – Parkville station	A construction work site in Elizabeth Street that currently houses the City Ford dealership, the northern section of University Square and Barry Street.
5 – CBD North station	A site bound by Swanston, La Trobe and Little La Trobe Streets in the CBD that is currently occupied by retail outlets and offices. A'Beckett Street between Stewart and Swanston Streets. Franklin Street west of Swanston Street to Stewart Street and Franklin Street east of Swanston Street to Victoria Street.
6 – CBD South station	A site located at City Square and sites located along Swanston Street, currently occupied by retail outlets.
7 – Domain station	Sites at Edmund Herring Oval, Albert Road Reserve and within St Kilda Road construction area to be used for materials laydown, site offices and facilities, as well as TBM launch site at Domain.
8 – Eastern portal	A site at the South Yarra Siding Reserve to be used to construct the eastern portal including all associated tunnel and track works to tie into the existing network. A site along Osborne Street for construction TBM retrieval shaft and ventilation facility, and a site in Chambers Street for construction.
9 – Western turnback	A site located within VicTrack land adjacent to West Footscray station.

6.6.4 Construction Workforce

Estimated peak numbers of construction workforce required onsite at any one time across all the work sites are 1,442 (that is, not total cumulative site numbers). A breakdown of the estimated peak workforce across each construction work site is provided in Table 6–7.

It should be noted that these workforce numbers represent an estimate of the workers on site and does not include other personnel that would be required to deliver Melbourne Metro and which would not be part of the on-site workforce. The additional personnel would include support offices for design and management, manufacturing plants etc and this could significantly increase the total number of jobs created by Melbourne Metro.

Separate economic wide modelling has been completed for the Melbourne Metro business case that identifies that Melbourne Metro would create 3,900 additional jobs (net) across Victoria and approximately 4,700 (net) additional jobs nationally are expected to be supported at the peak of construction (MMRA, 2016). This number includes the wider jobs created as a result of the project that are excluded from the construction workforce numbers outlined in Table 6–7.

Table 6–7 Estimated peak construction staff numbers across precincts (2017 – 2021, peak single shift personnel/day)

Location	Personnel (peak single shift/day)
Northern precinct	
Western portal	84
Arden station	421
Parkville station	169
CBD North station	151
CBD South station	151
Southern precinct	
Domain station	289
Fawkner Park	93
Eastern portal	84
TOTAL	**1442**

Table 6–7 Notes

1 Based on traditional Design and Construct contract form.

2 Project is broken into two precincts, north and south, and one Management and Administrative team covers each precinct.

3 On-site jobs only, does not include main contractors/subcontractor offsite personnel:

- Excludes off-site jobs that support the project through the provision of goods and services such as off-site manufacturing
- Excludes jobs related to raw material supply chain
- Excludes MMRA head office team but includes MMRA site based personnel.

4 If Domain only becomes the TBM launch site, the staff numbers would be 289 + 93 = 382.

6.6.5 Construction Hours and Durations

Indicative construction hours for each main construction work site are shown in Table 6–8. Generally, sites that would be subject to 24/7 work would require acoustic treatments (as described in Chapter 13) to manage amenity impacts of overnight works.

Table 6–8 Melbourne Metro indicative construction hours

Location	Construction Hours[1]
Above ground sections	• 7am – 6pm Monday to Friday • 7am – 1pm Saturdays • Sundays and Public Holidays (subject to approvals)
Stations upon placement roof slab/acoustic shed	• 24 hours per day, 7 days per week
Underground tunnelling works	• 24 hours per day, 7 days per week
Tunnelling support (Arden, Domain & Fawkner Park[2])	• 24 hours per day, 7 days per week

Table 6–8 Notes

1 The above working hours are subject to appropriate acoustic treatments being in place. Alternate hours may also be used subject to necessary third-party approvals.

2 Southern TBM launch site may be Domain only or Domain and Fawkner Park.

3 Construction work hours are subject to activities adhering to EPA Noise Control Guidelines or *Environment Protection Act 1970*.

Unavoidable works outside the hours specified above (as defined within EPA's Noise Control Guidelines, Publication 1254) would apply to a number of works across the project. These are works that cannot practicably meet the schedule requirements because the work involves continuous work or would otherwise pose an unacceptable risk to life or property, or risk a major traffic hazard. These may include (but not be limited to):

- Excavation and spoil removal including use of conveyors
- TBM support facility operations such as:
  - Segment casting
  - Concrete batching
  - Water treatment and water storage
  - Pump houses and slurry plant (silos and reticulation system)
  - De-sanding plant
  - Ventilation and cooling towers
- Construction of diaphragm walls and piling
- Concrete pours, shotcreting and associated batching

- Construction works where a road closure is required for safe construction
- Delivery of oversized plant and materials to site
- Tram diversion works
- Utility diversions
- Railway interface works
- Advanced grouting works.

The indicative construction timeframes and durations are shown in Table 6–9.

Table 6–9 Indicative construction occupation period for each major construction work site

Precinct	Activity	Indicative timeframes (construction durations)
Western portal	Construction work site (Cnr Hobsons Road and Kensington Road)	2018 – 2023 (3 years)
	Railway occupations	During period above
	Childers Street decline/cut and cover	2018 – 2021 (3 years)
	Construction shaft	2018 – 2020 (3 years)
Arden station	Tunnelling operations	2017 – 2023 (5 years)
	Construction site support facilities and station fit-out	
	Station box construction	2017 – 2021 (3 years)
	Tunnel fitout – first stage concrete works and rail systems (underground)	2019 – 2023 (3 years)
	Station fit-out	2020 – 2024/25 (3 years)
Parkville station	Station box construction	2017 – 2020 (3 years)
	Entrance structures	2019 – 2022 (3 years)
	Station fit-out	2020 – 2024/25 (3 years)
CBD North	Franklin Street shaft and entrances	2017 – 2023 (5 years)
	A'Beckett Street shaft	2017 – 2023 (5 years)
	La Trobe Street shaft and entrance	2018 – 2023 (4 years)
	Cavern and mined tunnels	2017 – 2021 (3 years)

Precinct	Activity	Indicative timeframes (construction durations)
	Station fit-out	2020 – 2024/25 (3 years)
CBD South	City Square shaft and entrance	2017 – 2020 (4 years)
	Southern shaft and entrance	2017 – 2020 (4 years)
	Cavern construction and mined tunnels	2017 – 2021 (3 years)
	Station fit-out	2019 – 2024/25 (3 years)
Linlithgow Avenue	Emergency access shaft construction	2018 – 2021 (3 years)
Domain station	Tunnelling operations, truck access	2017 – 2022 (4 years)
	Station box construction	2018 – 2020 (3 years)
	Station fit-out	2019 – 2024/25 (3 years)
Fawkner Park	Tunnelling operations	2017 – 2022 (4 years)
	Emergency access shaft construction	2018 – 2020 (3 years)
Eastern portal	Portal construction	2018 – 2023 (6 years)
	Railway occupations	

The indicative timeframes are the time period within which the construction durations would occur (that is, the construction durations may vary from indicative timeframes in that they may be a shorter duration within an overall indicative timeframe).

6.6.6 Construction of Stations

The main construction activities across each of the Melbourne Metro stations would be:

- Private property acquisition and demolition to establish a construction work site (where required) – noting there would be no private property acquisition required at Arden and Domain stations
- Early works for the relocation and protection of utilities (including electrical, gas, sewer, water, stormwater and telecommunications services)
- Establishment of construction work sites
- Advanced ground treatment to stabilise soils
- Station structural works

- Station architectural and mechanical and electrical fit-out
- Track works and installation of rail systems.

The construction method of cut and cover would be used for Arden, Parkville and Domain stations, while the cavern method of construction would be used at CBD North and South stations.

Cut and Cover Stations

The cut and cover method of construction involves the installation of retaining walls, excavating a trench or box to the required depth, building the tunnel or structure and then restoring the surface above the excavation. Cut and cover construction can be conducted through a top-down or bottom-up configuration.

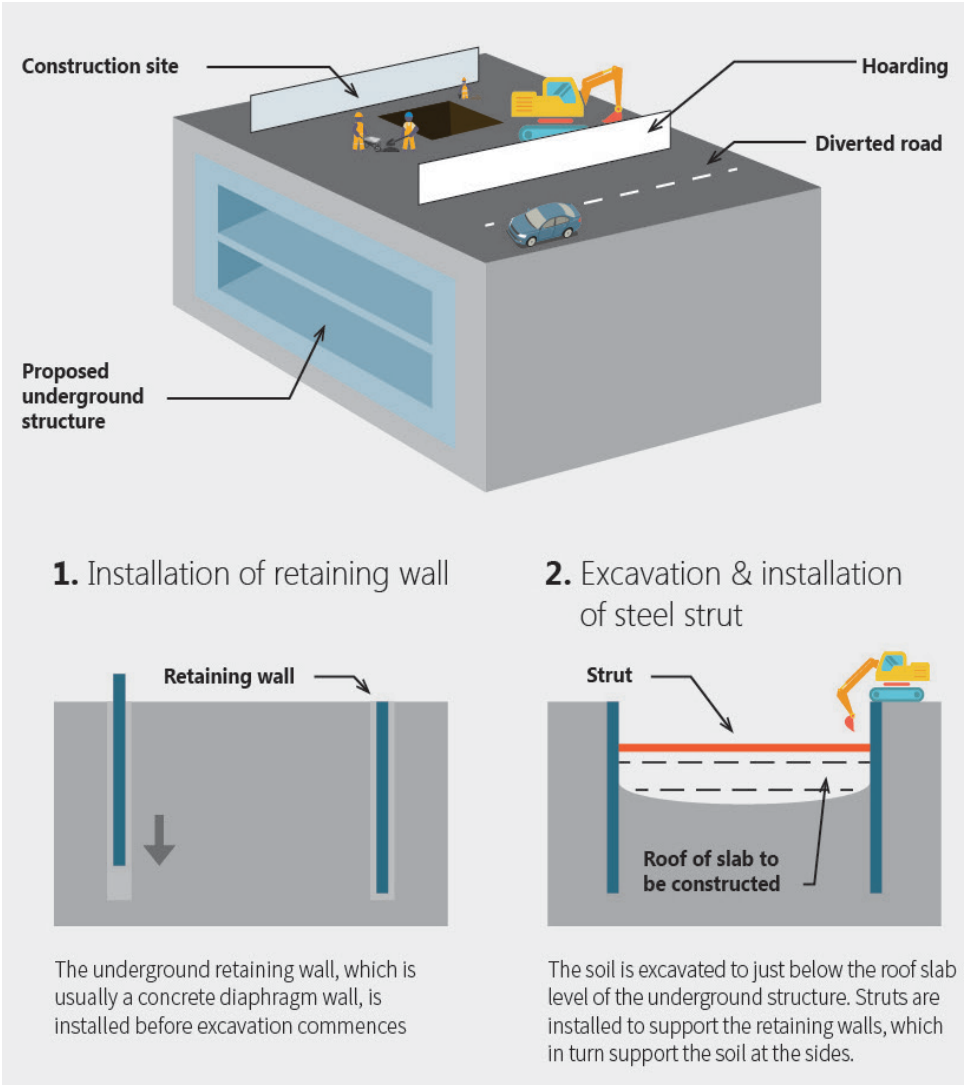
In the bottom-up method, the trench or box would excavated fully (supported by a temporary retaining frame) and the tunnel or station is constructed from the base slab upwards, removing the temporary supports progressively. After the walls are completed and a roof slab constructed, the trench or box would be backfilled to the surface. The bottom-up method is best suited to sites with good access and/or where the structure is complicated to construct.

In the top-down method, the permanent retaining frame would be constructed from the existing surface level. The trench or box is then excavated sufficiently to allow the construction of the permanent roof. The surface would be then restored except for access openings. Excavation would be then carried out under the roof through these openings. The base slab would be the last part of construction to be completed.

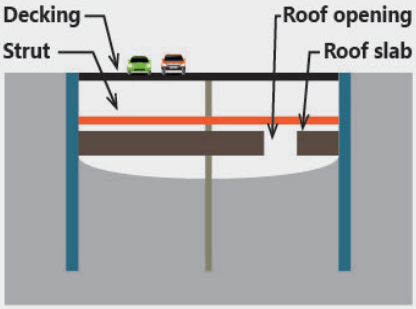
The top-down versus bottom up has the same construction elements in a difference sequence. Both can have work undertaken underground at night with appropriate acoustic provisions in place.

The top-down cut and cover construction method is illustrated in Figure 6-13.

Figure 6-13 'Top-down' cut and cover construction method

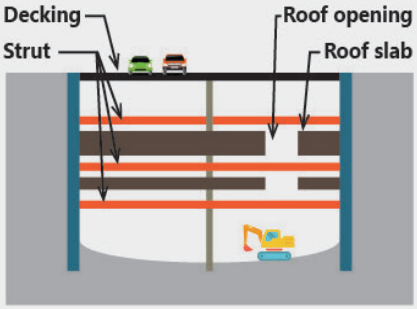


3. Construction of underground structure



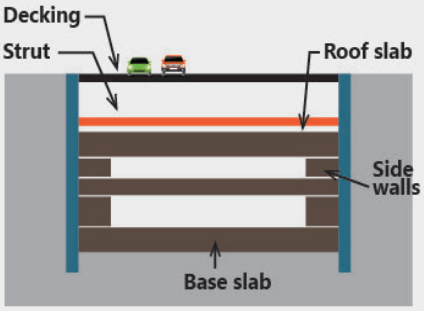
The roof slab is constructed, with access openings provided on the slab for works to proceed downwards. The roof slab not only provides a massive support across excavation, it also acts as a noise barrier.

4. Construction of underground structure



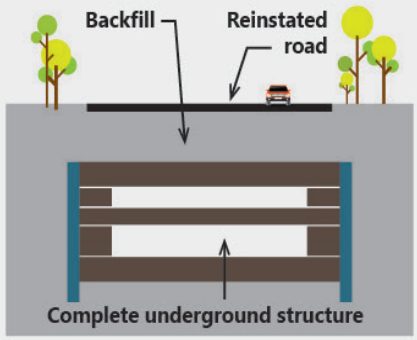
The next level of slab is constructed, and the process progresses downwards till the base slab is completed.

5. Construction of underground structure



The side walls are constructed upwards, followed by removal of the intermediate struts. The access openings on the roof slab are then sealed.

6. Backfilling & reinstatement



After the underground structure is completed, the soil is backfilled to the top strut level before the strut is removed. This is followed by completely backfilling the top of the underground structure and finally reinstating the surface areas.

A large cut and cover box is a common construction technique for underground railway stations. This construction form usually has two to three levels to accommodate ticket halls, station platforms, passenger access, emergency egress, ventilation and smoke controls, staff rooms and equipment rooms.

Station Caverns

Cavern stations are constructed from underground.

The caverns would be excavated using the Heading and Bench method. This is a sequential technique, whereby the upper section (heading) is excavated first, followed by the middle section (bench) and finally the lower section (invert). Roadheaders with a cutting head mounted on a crawler travelling track are used as the primary excavation equipment, as shown in the photograph below.

At CBD South and CBD North stations, the public entrance structures would be used as access shafts to enable construction of the station cavern from underground. These entrance shafts would be constructed using the cut and cover construction method.

Figure 6-14 Heading excavation using a roadheader

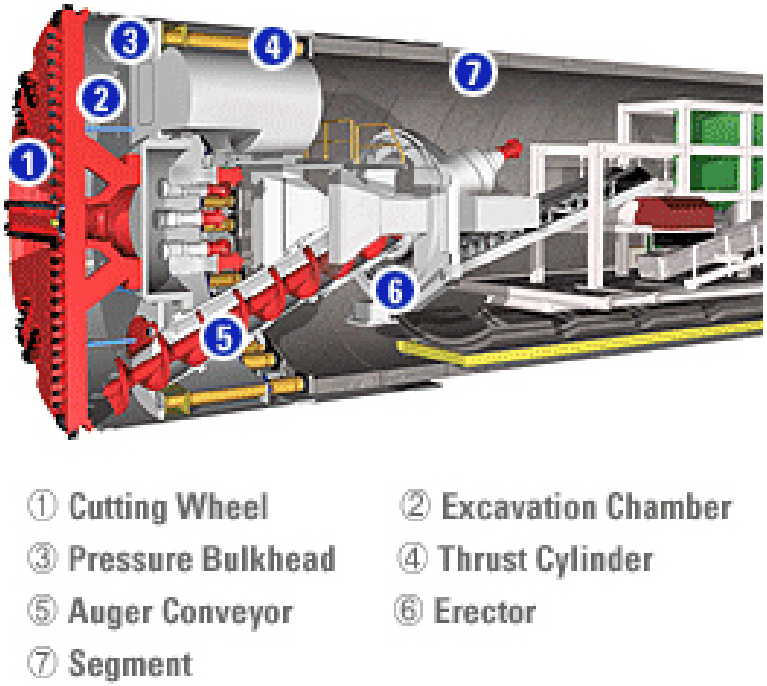
Source: World Highways, Bilbao benefits from major tunnel project, photograph, viewed 02 February 2016, < http://www.worldhighways.com/categories/road-highway-structures/features/bilbao-benefits-from-major-tunnel-project/>.

6.6.7 Construction of Tunnels

Tunnel Boring Machines

TBMs would be used to construct the majority of the tunnels required for Melbourne Metro. TBMs can be configured to excavate safely through a variety of soil and rock strata, with the permanent tunnel lining constructed in segments from within the machine as excavation progresses. The figure below shows the basic components of a TBM.

Figure 6-15 Basic components of a TBM



Source: Helpiks 2015, Shield Tunnelling, photograph, viewed 03 September 2015, <http://helpiks.org/2-30162.html>.

Mined tunnel

Mined tunnels use the same construction methodology as described for the station caverns (see Section 6.6.6 above).

6.6.8 Construction of Portals

Portals are the connections between the existing railway lines on the surface and the tunnels. Portions of the portals would be constructed through open cut/embankment methods.

Where there are land constraints at the proposed portal sites and the geology has low strength conditions to below formation level, earth retaining structures in the form of piles or sheet pile walls (see Section 6.6.9) are required to be constructed prior to excavation.

The main construction activities associated with both portals would be:

- Private property acquisition and demolition
- Early works for the relocation and protection of utilities (including electrical, gas, sewer, water, stormwater and telecommunications services)
- Establishment of work sites
- Advanced ground treatment to stabilise soils at the interface of the precincts
- Tunnel excavation and TBM retrieval
- Cut and cover excavation of the tunnel box
- Track works and installation of rail systems.

6.6.9 Retaining Walls

Three types of retaining wall systems are proposed as suitable perimeter retaining walls for stations and portals: diaphragm, secant pile and king post pile walls. These systems are expected to satisfy Melbourne Metro design requirements, performance criteria, assumptions and constraints.

Diaphragm walls are constructed in panels using specialised equipment to cut a narrow trench to the appropriate depth. The excavated area would usually be supported by bentonite to stop it collapsing while a reinforcement cage is installed and concrete is placed to displace the bentonite. Secant pile walls would be formed by constructing intersecting reinforced concrete piles. King post pile walls are typically reinforced piles spaced out with infill panels installed as the excavation proceeds.

The site specific constraints and geotechnical issues make certain options more attractive than others for the different stations.

Figure 6-16 Proposed retaining wall systems for Melbourne Metro

Diaphragm retaining wall

Secant pile retaining wall

King post pile retaining wall

Sources (from top to bottom):

1 Bulgarian Association for Geotechnical and Tunnel Construction (BAGTC) 2015, Methods for tunnelling construction, photograph, viewed 03 September 2015, http://bagtc.com/en/Methods+for+geotechnical+construction/1/Diaphragm+Walls.

2 Atule Education 2012, 4th-yr-Abcm-Contiguous Piled, Secant Piled & Diaphragm Basement Walls, photograph, viewed 03 September 2015, http://atule-education.blogspot.com.au/2012/04/contiguous-piled-secant-piled-diaphragm.html.

3 Keller UK 2015, King post retaining walls, photograph, viewed 03 September 2015, http://www.keller-uk.com/solution/king-post-retaining-walls.

6.6.10 Construction Traffic

Construction traffic on the project would comprise a mixture of truck configurations undertaking tasks such as spoil, concrete and construction material transport and, in some precincts, light vehicles for worker transport.

Estimated Construction Traffic

The large onsite workforce and constrained nature of the construction work sites on Melbourne Metro is anticipated to preclude the use of light vehicles for worker transport to sites due to minimal onsite parking provisions. Workforce travel would be from across the metropolitan area, spread across a 24-hour period, and is anticipated to utilise a mixture of light vehicles parking at private car parks, public transport, walking, bicycle and/or contractor-supplied shuttle buses to site. The additional demands associated with workforce travel activity are expected to be low and manageable by the contractors to minimise the disruption to others living and working in the vicinity of the various work sites.

Construction truck traffic would comprise a mix of configurations being used for spoil removal and delivery of concrete, materials and equipment. The estimated truck numbers at each project location during peak construction periods are summarised in Table 6–10 and Table 6–11.

Table 6–10 Construction truck numbers distributed over time (for southern TBM to be launched from Domain)

Location	Time-frame (months)	Average daily truck movements (total trips)	Months							
			1-6	6-12	13-18	19-24	25-30	31-36	37-42	43-48
Western portal	30	50	38	50	62	62	38	0	0	0
Arden station and tunnels	48	260	156	260	312	364	312	260	208	208
Parkville station	48	100	60	100	120	140	120	100	80	80
CBD North station	48	150	90	150	180	210	180	150	120	120
CBD South station	48	150	90	150	180	210	180	150	120	120
Linlithgow Avenue shaft	12	20	20	20	0	0	0	0	0	0
Domain station	48	100	60	100	120	140	120	100	80	80
Domain TBM site and tunnels*	24	140	112	168	168	112	0	0	0	0
Fawkner Park shaft	12	20	20	20	0	0	0	0	0	0
Eastern portal	30	50	38	50	62	62	38	0	0	0
Totals		**1,040**	**684**	**1,068**	**1,204**	**1,300**	**988**	**760**	**608**	**608**

Source: Advisian.

*The southern TBM site and tunnels includes the construction work sites at Fawkner Park and Linlithgow Avenue.

Numbers do not include light vehicles for site workers.

Table 6–11 Construction truck numbers distributed over time (for southern TBM to be launched from Domain and Fawkner Park)

Location	Time-frame (months)	Average daily truck movements (total trips)	Months							
			1-6	6-12	13-18	19-24	25-30	31-36	37-42	43-48
Western portal	30	50	38	50	62	62	38	0	0	0
Arden station and Tunnels	48	260	156	260	312	364	312	260	208	208
Parkville station	48	100	60	100	120	140	120	100	80	80
CBD North station	48	150	90	150	180	210	180	150	120	120
CBD South station	48	150	90	150	180	210	180	150	120	120
Linlithgow Avenue Shaft	12	20	20	20	0	0	0	0	0	0
Domain station	48	100	60	100	120	140	120	100	80	80
Domain TBM site and tunnels	24	70	56	84	84	56	0	0	0	0
Fawkner Park TBM site and tunnels	24	70	56	84	84	56	0	0	0	0
Fawkner Park Shaft	12	20	20	20	0	0	0	0	0	0
Eastern portal	30	50	38	50	62	62	38	0	0	0
Totals		**1,040**	**684**	**1,068**	**1,204**	**1,300**	**988**	**760**	**608**	**608**

Source: Advisian.

Numbers do not include light vehicles for site workers.

The estimated split of construction trucks by type over the project duration is provided in Table 6–12. This split would vary by month depending on the construction activities being undertaken.

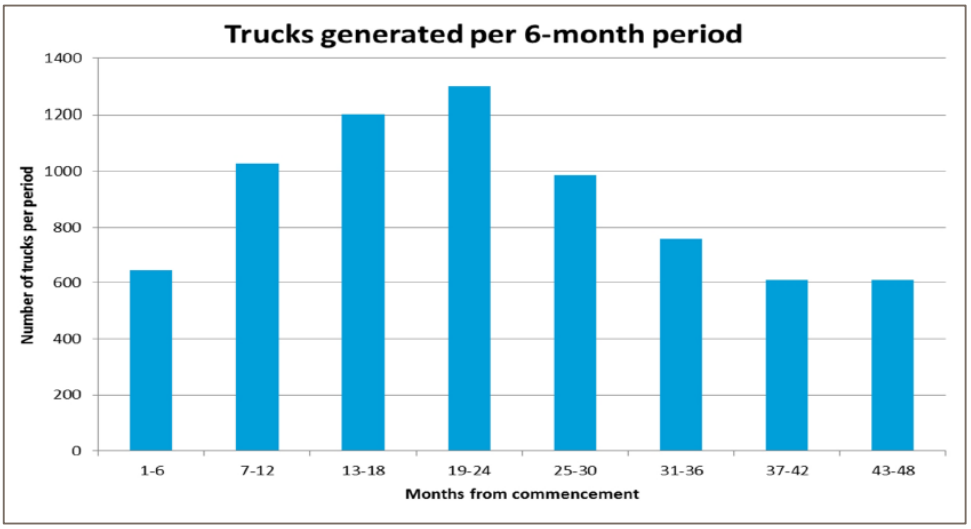
Table 6–12 Estimated split of construction trucks by type – total project

Truck type	% of total truck numbers
Spoil handling	33%
Concrete delivery	20%
Materials and equipment	47%

Source: Advisian.

As the work sites are within relatively close proximity, a holistic view of the impact of construction traffic from all locations is important to determining the cumulative impact on the road network. Figure 6-17 provides a summary of the average daily activity for construction trucks over six-month periods for the peak period of civil construction works. Further assessment of the road network impacts is provided in Technical Appendix D *Transport*.

Figure 6-17 Peak activity for construction trucks by six-month periods during peak construction period



Construction Traffic Routes and Management

The objective of the proposed traffic routes to support construction activities for Melbourne Metro is to provide efficient access for construction vehicles to the arterial road/freeway network and between work sites to minimise impacts on local traffic and local roads (to the extent possible). Proposed indicative traffic routes to and from construction work sites in each precinct have been developed for the project's construction phase. The main routes are shown in Figure 6-18 and route maps for each precinct are provided in Technical Appendix D *Transport*.

A traffic route study has been undertaken for the Concept Design to determine route selection likely to be adopted for construction site traffic. It should be noted that these preliminary construction traffic routes extend beyond the proposed project boundary and have been assessed as part of the EES. The traffic route study would be redone by the contractor(s) based on the detailed design and construction methodology.

With construction occurring in a densely developed, busy inner urban area, management of traffic impacts on adjacent roads would be a crucial component of project delivery. The contractors would be required to prepare and implement detailed traffic management plans to identify appropriate construction traffic routes, minimise transport disruption caused by construction works and activities, and mitigate the impact of displaced traffic on local road networks where possible (pending approval from relevant authorities). These issues are discussed in greater detail in Chapter 8 *Transport*.

Vehicle Standby Areas

Due to the constrained nature of some of the construction work sites, particularly in the CBD, staging areas are required to enable trucks to be called to site when there is sufficient parking area available for them. Local traffic management would be in place at all site locations to corral trucks safely onto site.

Staging areas increase the efficiency of work on heavily space-constrained sites and would mitigate queuing of trucks on public roads where they may obstruct pedestrian, cycle or traffic routes. Staging areas for vehicles are routinely used for major construction sites in the city.

Roads and Footpaths

To facilitate construction, it would be necessary to temporarily close and divert roadways (and introduce parking restrictions), cycle lanes and footpaths for extended periods at each site location. The key road closures and/or diversions that would be implemented during construction are:

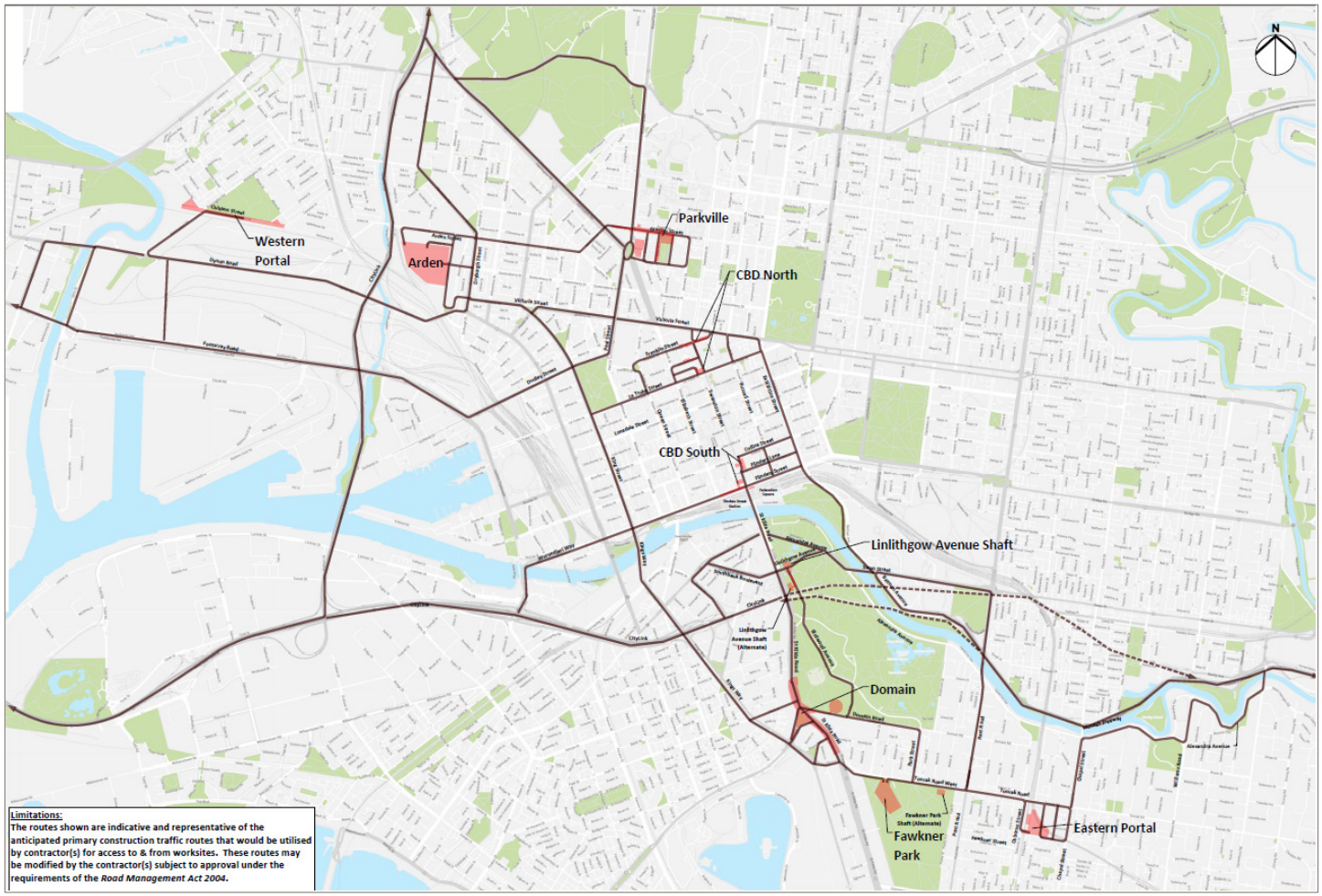
- Western portal: Childers Street (over-height vehicles provided access through construction site to service 50 Lloyd Street Business Estate), Ormond Street (occupation at the end of street and parking restrictions) and Tennyson Street (parking restrictions)
- Parkville station: Grattan Street (Royal Parade to Leicester Street, and Royal Parade to Flemington Road traffic restrictions) and Barry Street
- CBD North station: Franklin Street (Swanston Street to Bowen Street closure and lane closure west of Swanston Street) and A'Beckett Street (eastern end)
- Domain station: St Kilda Road (lane closure), Domain Road and Albert Road (both closed at St Kilda Road intersection)
- Eastern portal: William Street bridge.

The key cycle route closure (in addition to road closures) is the Childers Street off road cycle path diversion. Pedestrian closures and diversions include the southern footpath on Childers Street and Grattan Street (between Barry and Leicester Streets).

Minor and localised diversions and closures of pedestrian, cycle or traffic routes in addition to the above would be required to facilitate construction activity.

Further information on closures is provided in Technical Appendix D *Transport.*

Figure 6-18 Indicative main traffic routes for construction traffic



6.7 Operation and Maintenance

6.7.1 Operation

Melbourne Metro would establish a new metro-style north-west to south-east rail corridor joining the Dandenong corridor with the Sunbury corridor through Parkville and the CBD.

The future tunnel section of the Sunshine to Dandenong Line is expected to operate as a two-track railway, providing high frequency suburban services to the underground stations in both directions during normal operations.

At peak capacity, trains through the tunnels are expected to be scheduled with an average 2½ minute separation to facilitate coordination of connections with other modes, operating on 10-minute base frequencies and aligning with a 24 trains per hour capacity outcome in subsequent years.

Melbourne Metro would assist in lifting the core capacity and reliability of the metropolitan rail network. The project would create the opportunity to increase service capacity on existing rail corridors, provide the capacity to enable future electrified services to operate from Melton and alter the routing and operating patterns of a number of lines from the south-east, northern and western suburbs.

6.7.2 Maintenance

Maintenance on Melbourne Metro would consist of regular planned activities to maintain the track, trains, signalling system, power, tunnels, stations and ventilation system to a standard that meets the requirements of its ongoing operation. These activities would be broadly commensurate with those currently undertaken on other lines operating as part of the Melbourne metropolitan rail system, including the City Loop tunnel and stations.

6.8 Waste, Spoil and Groundwater Management

6.8.1 Waste

Opportunities would be considered to minimise the production of waste in accordance with the principles set out in the *Environment Protection Act 1970*. Construction waste streams, such as concrete, metal, green wastes and spoil, would be separated from other waste items for recycling or reuse. General waste and recycling facilities would be provided to collect waste prior to disposal. All work areas would be kept clean and tidy and free of litter.

Waste disposal methods would be selected based on the classification of waste material in the EPA Industrial Waste Resource Guidelines. All wastes generated by Melbourne Metro would be transported, managed and disposed of in accordance with the relevant EPA Victoria requirements.

6.8.2 Spoil

The works would generate approximately 2 million cubic metres of spoil from tunnels, stations and other structures.

The quantity of spoil expected to be produced exceeds an amount that could be re-used in the construction of Melbourne Metro, meaning spoil would need to be transported to an off-site location. During detailed design, the contractor would be required to adopt waste management handling practices consistent with the *Environment Protection Act 1970* when assessing options for spoil management.

A spoil management plan would be prepared by the contractor(s) to meet the MMRA spoil management strategy, which is provided in Technical Appendix Q *Contaminated Land and Spoil Management.*

Overall, the excavation, handling and transport of spoil would require approximately 170,000 return truck movements (340,000 one-way truck movements) and the identification and use of traffic routes to off-site locations for spoil disposal.

Indicative spoil volumes are summarised in the table below.

Table 6–13 Summary of estimated spoil quantities

Location	Approx. volume of spoil (cubic metres)	Approx. number of return truck movements (number)	Approx. spoil generation timeframe (months)
Tunnel spoil	613,000	49,040	18
Station spoil (incl. roadworks)	1,316,300	105,305	19
Other structures spoil (portals, cut and cover, decline structures)	104,200	16,030	31
Total	**2,033,500**	**170,375**	

Notes to Table 6–13

1 Volumes are in-situ volumes (dense m^3) and do not include bulking factor.
2 Truck numbers allow bulking factor of material of 30 per cent.
3 Truck volumetric capacity assumed by location (dense m^3), factoring in 'unbulked' volumes:
- Eastern and western portal sites (truck only) = 6.5
- All other locations (truck & dog) = 12.5
- Quantities based on material take-off from Concept Design as at 28 October 2015.

6.8.3 Groundwater

Melbourne Metro is proposed to be constructed at or below the ground water level in a number of locations and would therefore directly interact with groundwater during both the construction phase and, to a lesser extent, once operational.

During construction, groundwater would be encountered across the majority of the project alignment through construction activities comprising:

- TBM tunnelling
- Mined tunnel and cross passage excavation
- Station, shaft and portal structure excavation.

Groundwater modelling based on the concept design construction methodology predicts approximately 380 ML of groundwater inflow would be generated at the site locations during the main works construction period from late 2017 to late 2021. Peak inflow rates to be managed would be approximately 6.5L/s total across all site locations. Groundwater that flows into excavations and structures would need to be extracted and disposed of appropriately. A groundwater management plan or similar would be prepared by the sontractors to address the MMRA Groundwater Disposal Strategy, which is provided in Technical Appendix O *Groundwater*.

Melbourne Metro would be designed as a tanked (sealed) structure. Accordingly, upon commissioning and during operations, all the station and tunnel structures would be expected to have minimal groundwater inflows.

6.9 Property Acquisition

The extent of tunnelling proposed for Melbourne Metro means that surface property acquisition requirements are limited largely to the locations of the tunnel portals, station boxes and other surface infrastructure, rather than extending along the full alignment. This would result in a relatively low number of whole properties requiring acquisition (as opposed to partial underground strata only acquisition). In instances where compulsory acquisition is required, the *Major Transport Projects Facilitation Act 2009* and *Land Acquisition and Compensation Act 1986* would be applied and compensation for parties with an interest in the land would be provided.

In addition to surface property acquisition, underground strata would need to be acquired from a number of titles where the rail tunnels pass under properties. The property at surface level is not required in this type of acquisition. For strata acquisition, MMRA would utilise the provisions of the *Major Transport Projects Facilitation Act 2009* to have the land declared (that is, acquired) as 'underground land' for the project. Once declared, any person who previously held a legal or equitable interest in the land would have a claim for compensation. Any claim would be determined under the compensation provisions of the *Land Acquisition and Compensation Act 1986*.

For the limited circumstances in which temporary occupations on private land would be required, MMRA would use the temporary occupation provisions under the *Major Transport Projects Facilitation Act 2009* and the *Land Acquisition and Compensation Act 1986*. This Act includes provisions for compensation including payment of rent for occupation of the land. For temporary occupations on public land, MMRA may use the provisions under the *Major Transport Projects Facilitation Act 2009* and *Land Acquisition and Compensation Act 1986* for use, occupation or temporary access of public land such as roads, parks and Crown land reservations.

A summary of above ground property titles, and underground strata, required for permanent acquisition is provided below. Further information about property acquisition is provided in Chapter 9 *Land Use and Planning*, Chapter 10 *Social and Community* and Chapter 11 *Business*.

Table 6–14 Proposed permanent acquisition of private property titles

Precinct	Permanent acquisition				Temporary occupation	Underground strata acquisition
	Commercial	Residential	Other	Total titles (street addresses)		
1 – Tunnels						
Sector 1: Western Portal to Arden station	–	–	–	–	–	16
Sector 2: Arden station to Parkville station	–	–	–	–	–	715
Sector 3:Parkville station to CBD North station	–	–	–	–	–	2335
Sector 4: CBD North station to CBD South station	–	–	–	–	–	–
Sector 5: CBD South station to Domain station	–	–	1	**1 (1)**	–	1
Sector 6: Domain station to Eastern Portal	–	–	2	**2 (2)**	1	341
2 – Western portal#	13	9	3	**25 (25)**	1	
3 – Arden station	–	–	–	–	–	–

Precinct	Permanent acquisition				Temporary occupation	Underground strata acquisition
	Commercial	Residential	Other	Total titles (street addresses)		
4 – Parkville station	2	–	1	**3 (3)**	2	1 (part)
5 – CBD North station*	9	49	2	**60 (9)**	–	14
6 – CBD South station	8	–	5	**13 (11)**	1	2
7 – Domain station	–	–	2	**2 (2)**	2	13
8 – Eastern portal	–	9	–	**9 (8)**	2	13
9 – Western turnback	–	–	–	**–**	–	–
TOTAL	**32**	**67**	**16**	**115 (61)**	**9**	**3450 1 (part)**

* Includes five car park spaces beneath City Square.

There is no commercial acquisition and only one residential acquisition for the variation at the western portal.

In addition to these private property acquisitions, approximately ten commercial leases on publicly owned (VicTrack) land would be either acquired or not be renewed.

6.10 Sustainability Principles and Approach

MMRA believes that Melbourne Metro would give rise to positive environmental and social effects in the long term and has a commitment to achieving excellence in sustainability and climate change resilience.

This section describes the overall approach to sustainability adopted on Melbourne Metro and the governance structure being implemented to support the delivery of MMRA's Sustainability Vision and Sustainability Targets throughout the lifecycle of the project.

Infrastructure Sustainability Definition and Vision

There are various definitions of sustainability or sustainable development. One of the first descriptions of sustainable development that is frequently referred to comes from *The World Commission on the Environment and Development Report* (Brundtland report) of 1987, which defines sustainable development as:

> *"… development that meets the needs of the present without comprising the ability of future generations to meet their own needs".*

Australia's *National Strategy for Ecologically Sustainable Development* (ESD) (1992) defines ecologically sustainable development as:

> *"… using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased".*

Infrastructure sustainability for Melbourne Metro is inclusive and has been defined as infrastructure that is designed, constructed and operated to optimise environmental, social and economic outcomes over the long term.

Melbourne Metro is committed to achieving excellence in sustainability through adopting and implementing a Sustainability Policy which has the following Policy Vision:

> *"To achieve excellent environmental, social and economic outcomes across all phases of the Project in order to deliver an integrated Project that connects the community in an environmentally sustainable manner".*

MMRA's Sustainability Policy, Themes and Targets

To ensure that sustainability is implemented across all phases of the project and to deliver the commitments outlined in its Vision and Policy, MMRA has prepared a Sustainability Strategy outlining Themes and Targets. These Themes and Targets would be applied to all contracts for the delivery of Melbourne Metro.

The sustainability Themes and Targets are detailed in Table 6–15.

Table 6–15 Melbourne Metro's sustainability Themes and Targets

Theme	Key outcomes to be sought in targets
	**Excellence** • Achieving excellent ratings against key sustainability rating tools • Publically reporting sustainability performance on an annual basis
	**Urban Ecology and Vegetation** • Contributing to urban forest and biodiversity targets set out by other authorities
	**Climate Resilience** • Undertaking climate change risk assessment and implementing adaptation measures
	**Supply Chain** • Developing and implementing local content strategies in line with key state policies and ensuring local SMEs are suitably involved in the project supply chain
	**Communities** • Ensuring project design leaves a positive legacy for Melbourne • Ensuring heritage and identity are appropriately incorporated in project design • Demonstrating how potential project impacts to the community have been considered, addressed and monitored
	**Workforce** • Developing and implementing workforce strategies in line with key state policies to encourage skills transfer, employment of apprentices/trainees, training programs and indigenous employment
	**Energy** • Reducing greenhouse gas emissions and energy consumption and encouraging the use of renewable energy during project construction and operation
	**Materials and Waste** • Reducing materials use during project construction including cement, timber and steel • Encouraging diversion of waste during project construction from landfill
	**Water** • Reducing water use, reducing potable water use and minimising urban stormwater impacts during project construction

Governance and Performance Management

Sustainability Management System

MMRA would maintain a Sustainability Management System (SMS) that is integrated into all project deliverables and activities. The SMS would ensure that effective assurance processes are implemented to monitor performance against the Sustainability Policy, Themes and Targets.

Sustainability Rating Tools

MMRA would require the use of two key sustainability rating tools to benchmark and monitor the Melbourne Metro's performance against the sustainability Themes and Targets. These tools are:

- Infrastructure Sustainability Council Australia (ISCA) – a comprehensive rating system for evaluating sustainability across design, construction and operation of infrastructure
- Green Building Council Australia (GBCA) – a comprehensive, national, voluntary environmental rating system that evaluates the environmental design and construction of buildings.

Technical Appendix W *Sustainability Principles and Approach* contains further information about the SMS and sustainability ratings tools.

6.11 Urban Design Strategy

Melbourne Metro is much more than a transport project; it is also a major urban design challenge that would change the way people use and perceive the city every day. If done with care, it would enrich urban amenity and contribute to the culture of design excellence that is a hallmark of Melbourne. Meeting this challenge would require vision and a commitment to high quality and integrated design that contributes to and enhances Melbourne's reputation for design excellence – it demands a collaborative and multi-disciplinary approach with a high level of expertise in urban design, architecture, landscape architecture, industrial design and integrated urban art.

To deliver on these design aspirations, a project-wide Urban Design Strategy has been developed for Melbourne Metro. The purpose of the strategy is to provide urban design guidance, procurement and implementation of Melbourne Metro. The strategy also seeks to minimise adverse visual impacts from Melbourne Metro and enhance visual amenity where the alignment interfaces with the surface. Innovative and expressive contemporary design would be part of the project's contribution to Melbourne, but respectful integration with the public realm is of equal importance. This is a key focus of the Melbourne Metro's Urban Design Strategy and of vital importance to the project itself.

The strategy was developed in consultation with stakeholders and government authorities provides urban design guidance relating to the design, procurement and implementation of Melbourne Metro. It is intended to:

- State the broad urban design expectations for Melbourne Metro
- Ensure the landscape and visual impacts identified in Technical Appendix L *Landscape and Visual* are addressed in a way that maximises Melbourne Metro's positive contribution to Melbourne
- Set out design criteria that, along with further detailed content, would inform the technical specifications for Melbourne Metro's procurement phase
- Identify areas of concern to be assessed through expert peer review processes during the development and finalisation of designs for Melbourne Metro.

The Urban Design Strategy builds upon the characteristics and urban setting of each precinct and identifies opportunities created by investment in Melbourne Metro to contribute to a lasting, high quality public realm.

The strategy may also be applied to broader opportunities and future projects that are outside the scope of Melbourne Metro, but may be influenced or impacted by the project.

The Urban Design Strategy is provided in Technical Appendix M.