5.3.2 Typical Metro Systems

Metro systems have been introduced in many international cities (Madrid, Spain; London, Paris, New York, Washington, Singapore, Hong Kong). These systems have limited seating and several doors on each side of the carriage. This design allows a high capacity with a larger number of standing passengers and faster times for passengers to move in and out of the carriages, reducing station dwell times. These metro systems operate in higher density cities in inner metropolitan areas and rely on interchanges with suburban rail systems to serve commuters from further afield. Metro systems are typically introduced to cater for high volume, short distance passenger trips.

A metro system generally has the following characteristics:

- capacity to transport up to 20,000 people per hour;
- typical average operating speeds between 35 and 65 kilometres per hour depending on geometry and other design parameters;
- exclusive rights of way and protected at-grade crossings with grade-separation preferred;
- a corridor width of 12 metres for track sections and 18 metres at stations;
- stations spaced at between 1 to 2 kilometres apart, the adjacent residential density or the location of employment and commercial and use; and
- a minimum radius of 50 metres and 400 metres at platforms with a maximum gradient of 6 to 8 percent.

Paris Metro System

5.3.3 High Capacity Rail Options in the F6 Corridor

Previous planning studies, such as the Long Term Strategic Plan for Rail (Christie Report) have suggested that a metro style network may be introduced in Sydney and that the F6 corridor could potentially form part of such a system. Integrating a metro style rail system with a heavy rail system such as exists in Sydney is also subject to a range of technical complexities. It is not the purpose of this document to elaborate on these issues other than in as much as these affect the future boundaries of the corridor. Given that the design criteria for heavy rail are in all cases more stringent than those for a metro system, considering heavy rail only should not preclude the construction of a metro system in the corridor at any time in the future.

The initial assessment of options identified two route options, and these are assessed in more detail as part of the study:

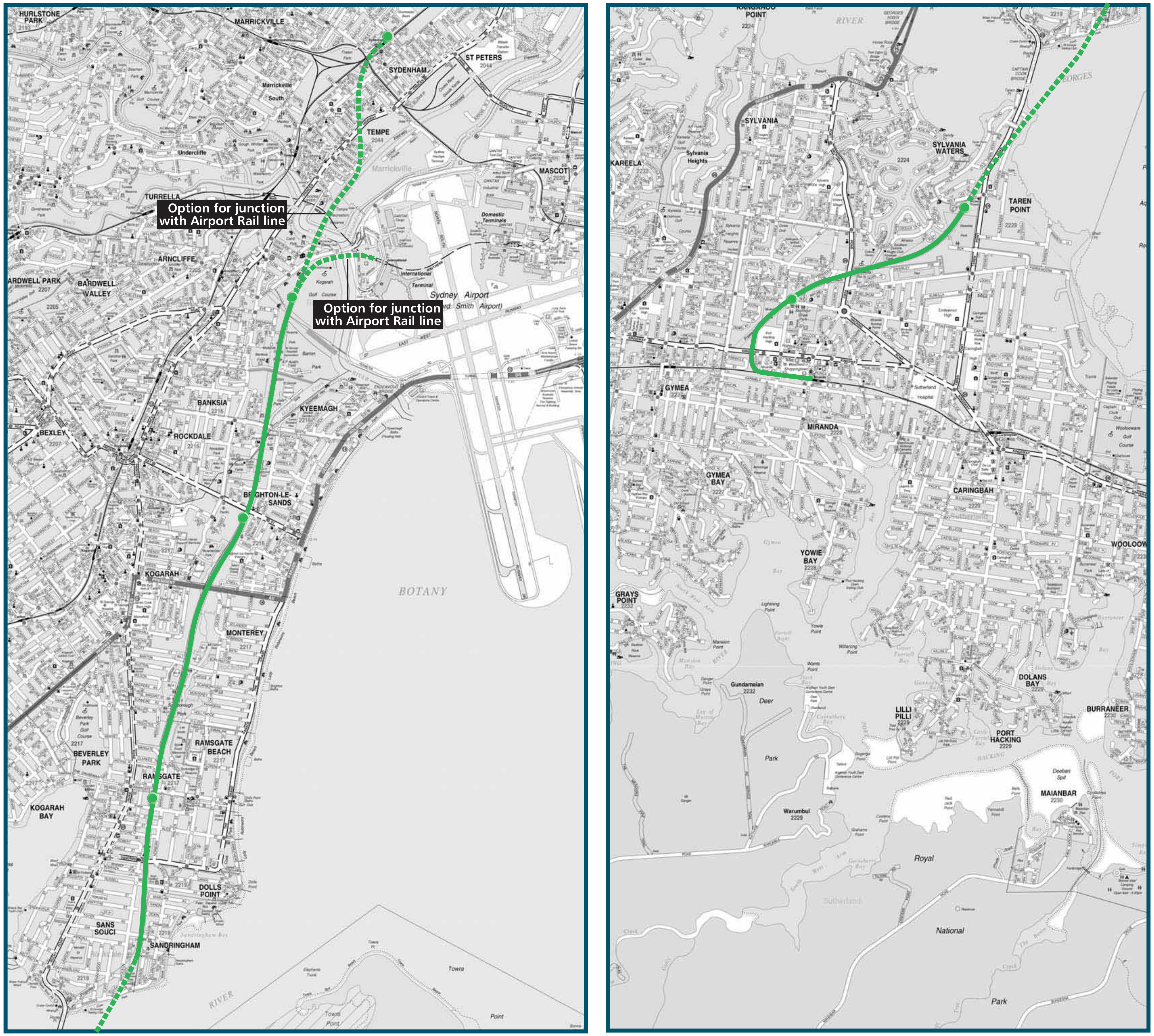
- Miranda to Sydney City via Miranda and Sydenham; and
- Miranda to Sydney City via Miranda and Airport.

A high capacity rail line would need to connect to the network such that it provides access to the City if it is to meet the travel demand, and both options are therefore proposed to connect to lines that continue to the City:

- the first option connects to the Illawarra Line at Sydenham, which continues to Central and then through the City to Bondi Junction via the ESR; and
- the second option connects to the Airport Rail Link at International Terminal Station, which continues to Central and then through the City via the City Circle.

The two options are shown in *Figure 5.3*. Both options start at Miranda and head west looping onto the F6 alignment, collecting trains from Cronulla. It is noted that the analysis of Wollongong travel data in *Section 4.2*, together with StateRail advice during the reference group workshop concluded that a connection to the Illawarra Line south of Gymea station on the Cronulla line would not be required. The key considerations being:

- trains would miss Sutherland, Hurstville and other major employment and commercial centres to the north; and
- there is very little demand for access to the F6 Corridor by commuters from the Illawarra Region.



Indicative railway on surface

Indicative railway in tunnel

Indicative station location

Scale: 0 – 1.0 – 2.0 – 3.0 Kilometres

Figure 5.3 **HEAVY RAIL OPTIONS**

- The limiting factor affecting future growth in train travel from the Illawarra is the capacity along the Illawarra Line north of Sutherland. The introduction of either a new train service or alternative public transport improvements in the F6 corridor could serve as an alternative to infrastructure enhancements north of Sutherland to relieve these capacity constraints.

Both options then follow the F6 reservation north, via a new crossing of the Georges River, to a point just south of the Cooks River. From this point, the two options differ as one diverts to Sydenham Station to connect into the Illawarra line while the other is to connect to the Airport Line west of the International Terminal Station.

It is most likely that both options would need to divert underground south of the M5 to avoid the M5, SWOOS, and Cooks River and would remain underground to the vicinity of Sydenham station where new underground platforms would be required. The Airport Line connection would also go underground.

5.4 Medium Capacity Modes

Medium capacity modes are considered as either a light rail transit system or a bus based transit system. They are highly flexible modes and can be integrated with surrounding environments to provide for medium volume short passenger trips. Medium capacity modes bridge the gap between heavy rail and local bus services.

A medium capacity mode generally has the following characteristics:

- capacity for up to some 20,000 passengers per hour;
- typical operating speeds between 30 to 60 kilometres per hour;
- priority or shared environments;
- corridor width of 12 metres for track sections and 14 to 22 metres at stations;
- stations spaced at between 800 metres and 2 kilometres apart, depending on land uses;
- light rail systems have an absolute minimum radius of 25 metres and 300 metres at platforms with an absolute maximum gradient of 6 to 8 percent;
- bus based systems have an absolute minimum radius of 10 metres with a maximum gradient of 8 to 15 percent; and
- low floor vehicles allowing for high quality accessible stations.

5.4.1 Typical Light Rail Systems

There are different categories of light rail systems depending on their operating areas, catchment and service requirements. Light rail systems can be built as:

- entirely new exclusive track in an exclusive alignment on the surface, elevated or in tunnel;

- new track on an existing roadway converted to exclusive use by the light rail system; or
- track embedded on roadways that are also used for private vehicles.

The performance of light rail systems varies according to the level of priority relative to other modes, station locations, boarding and alighting capacities. In suburban areas, light rail vehicles can be routed along sections of heavy rail track. In these cases, vehicle design need to be able to operate on two different system and stations need to be equipped with both high level and low level platforms. In the case of the F6 Corridor, it is unlikely that interoperability with heavy rail will be required.

Light rail systems have been developed through green strips or parks in many cities. They require low investment and maintenance costs and offer a pleasant travel environment minimising visual impacts.

Examples of Light Rail Systems: Sydney and Zurich

5.4.2 Typical Bus Transit Systems

Bus based transit systems operate on purpose built exclusive right of way or with priority on existing roads. Systems are designed to suit its urban environment and patronage demands.

A bus based transit system can provide high quality, frequent and fast travel between centres. Services can be integrated to allow for line haul high frequency services, local feeder services and integrated feeder express services. This means that local bus services collect passengers through residential areas then operate express on the right of way sections. Technology (through the application of compressed natural gas (CNG), hybrid and fuel cell vehicles) has allowed the development of several vehicles that provide a higher quality level of service, comfort and environmental performance than typical diesel buses. These technologies, applied to bus based transit systems, have raised the performance and profile of services.

Examples of Bus based systems, Liverpool to Parramatta Transitway and Rouen, France (TEOR System with CIVIS vehicle)

Medium capacity mode options were developed and reviewed at a Reference Group workshop.

5.4.3 Medium Capacity Options in the F6 Corridor

Two medium capacity options were developed for the F6 corridor. At this strategic level of assessment the medium capacity option has been based on either light rail or bus transit system. Each mode requires a similar cross section and exhibits similar performance characteristics. Future more detailed studies would determine the most appropriate mode based on meeting the travel needs of the population. Accordingly, while the routes for both these options could be served by either light rail or bus-based transit systems, they were developed to ultimately suit the engineering requirements of light rail systems:

- medium capacity modes in an exclusive corridor; and
- medium capacity modes on street.

The first option is based on the F6 alignment and could be grade separated at major junctions along the F6 alignment in its long term configuration. The route originates at Kiora Road in Miranda, turns west down The Kingsway to join the F6 alignment. The route follows the F6 alignment for its entire length, including Captain Cook Bridge over the Georges River, up to Tempe where it diverts to Sydenham Station. There is an option for a connection to the International Terminal at Sydney Airport via a crossing of the Cooks River.

It may be desirable to have a direct light rail/bus transit system connection to the CBD rather than provide an interchange with the Illawarra Line at Sydenham Station or the Airport Line at the Interantional Airport, but evaluation of such a direct connection does not form part of this study.

The second option is a road-based option that would have minimal diversions from the existing road network. The route would not be grade separated at junctions but would have signal priority and bus lanes where possible.

The route of the on-road option is as follows:

- the route originates at Kiora Road in Miranda and turns east down The Kingsway; from where it proceeds;

- north along Taren Point Road (Miranda and Taren Point), over the Captain Cook Bridge, following Rocky Point Road (Sans Souci), and then east along Sandringham Street. It then proceeds;
- north along Chuter Avenue (Ramsgate), east along President Avenue, north along Crawford Road (Brighton Le Sands), at this point two options have been identified which show:-
  a) east on Bay Street; and then north on Moate and Jacobson Avenue. The alignment would then cross over Muddy Creek and on a new bridge alignment or a tunnel depending on clearances around the airport runway envelope and the M5; and continue through the Cooks Cove development, before crossing the Cooks River to the international and domestic airport terminals; or
  b) west on Bay Street to West Botany Street to Marsh Street to the F6 alignment where it would then cross the Cooks River before linking up with the proposed St Peters Industrial Route (SPIRE) from where it diverts to Sydenham Station.

As with the exclusive corridor option it may be desirable to have a direct light rail/bus transit system connection to the CBD rather than provide an interchange at the Airport Line or illawarra Line at Sydenham. The routes for the two medium capacity options are shown in *Figures 5.4* and *5.5*.

Indicative medium capacity modes in F6 corridor (on surface)

Indicative location of station on busway or light rail in F6 corridor

Figure 5.4 **MEDIUM CAPACITY MODES IN EXCLUSIVE CORRIDOR**

N

Scale 0 1.0 2.0 3.0 Kilometres

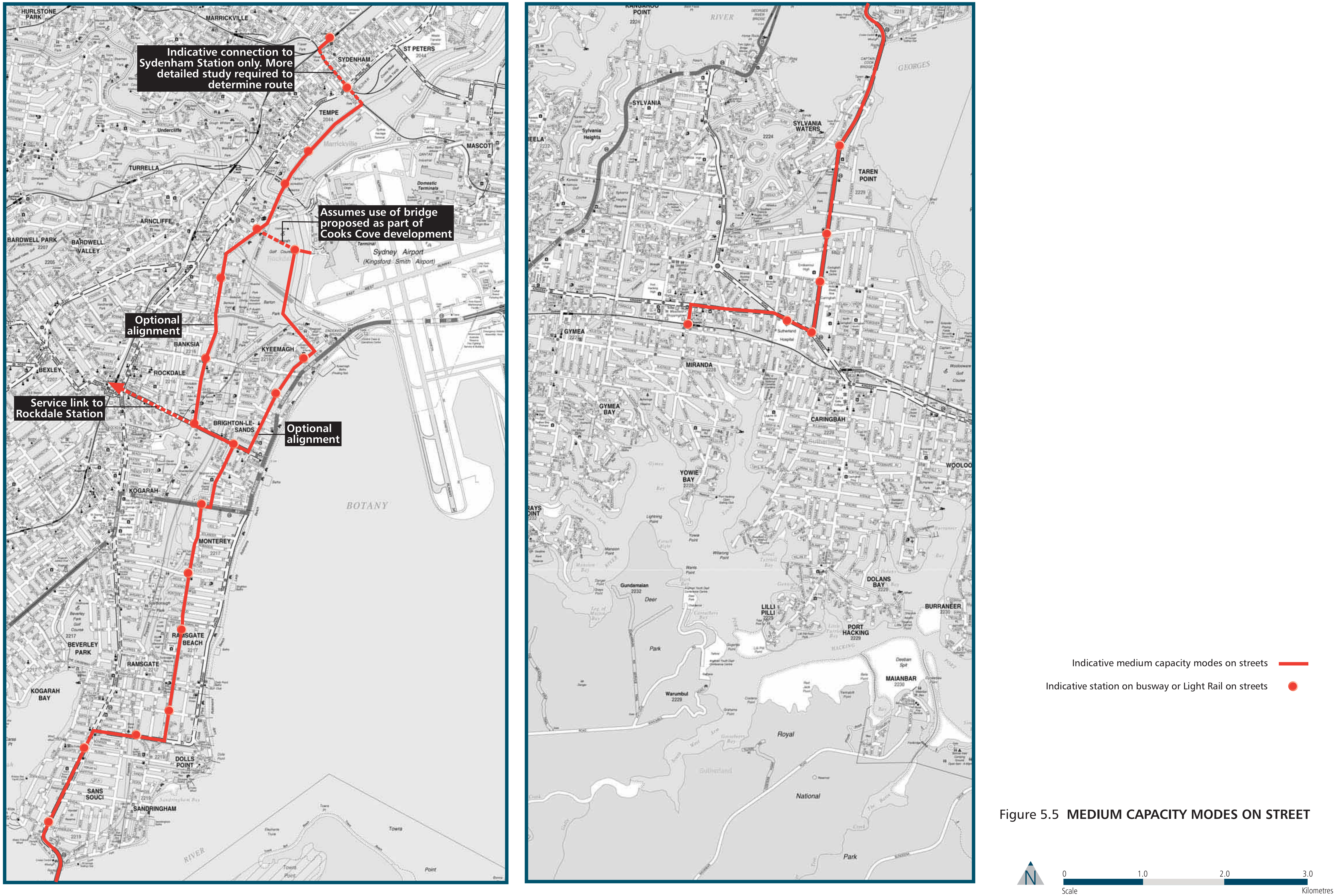


Figure 5.5 **MEDIUM CAPACITY MODES ON STREET**

5.5 Other Technology

There have been many advances in technology across most modes in recent years. These include light rail vehicles, bus propulsion systems that deliver low emissions, guidance technology (for example O-Bahn and optical guidance) and new forms of transit vehicles (for example Civis[3]). New and emerging technology could be applied to a public transport system for the F6 corridor. However, it should be noted that at this strategic stage of assessing potential public transport uses for the corridor, the focus is on quality of services and market demands rather than technology alone.

5.5.1 Guided Bus Technology

Guided bus technology has been developed as a possible alternative to light rail technology. Most guided buses are conventional buses fitted with equipment to enable them to run on special tracks as well as on regular streets. The most commonly referred to example is the German designed O-Bahn system that operates in Adelaide, Australia. This system involves self-steering, kerb-guided buses running on a special concrete track. The main advantage over a bus based system is the higher speed that can safely be achieved on a restricted right of way. Automatic steering permits this right of way to be only fractionally wider than the bus itself. However, the track profile does not permit at-grade crossings by pedestrians, cyclists or other vehicles. The right of way requires a special guideway which means that other buses or other vehicles are not able to use it, raising additional costs for service integration.

Either of these technologies, O-Bahn or Civis Vehicles, could be applied to the medium capacity options assessed for the F6 corridor. A decision on whether this technology is appropriate to the F6 Corridor would be made at the design stage and would be dependent on whether the minimisation of the final right-of way width is a priority. The corridor width reserved as a consequence of this study is wide enough to accommodate a full-width busway without guidance requirements.

O-Bahn

Civis

[3] *CIVIS is a bus rapid transit vehicle manufactured by Irisbus of France. It has four wide doors and a low floor, allowing for fast and easy boarding and handicap accessibility. The vehicle looks more like a tram than a bus, and runs on rubber tires.*

5.5.2 Ultra Light Rail

New technology such as the Austrans Ultra Light Rail (ULR) system, offers a possible alternative to other medium capacity modes. The Austrans vehicle is driverless and has the capacity to seat nine passengers in coach style seating and carry up to a further 9 standing passengers in the peaks. With 15-second headways and on-line stations Austrans is able to carry approximately 4,000 passengers per hour per direction.

In theory, the footprint required to implement and operate the ULR is significantly narrower than other modes (less than 6 metres width for a double track) and the system has the potential to provide a quieter, energy efficient and less visually obtrusive alternative. Stations are also short and narrow. The vehicle specifications capable of climbing 20% gradients and can negotiate 8-metre radius turns. The guideway is small and lightweight and can be attached to existing structures for example, the Captain Cook Bridge, Austrans could therefore be more adaptive to existing transport infrastructure than other medium capacity options. An additional advantage claimed by Austrans is that in typical urban applications it does not require a subsidy from Government. Austrans' claims that, typically, fare revenue would exceed its operating costs and it can make a contribution to capital costs. In addition it offers passengers advantage through very high frequency services (headways of less than one minute are claimed) and high levels of passenger comfort (based on Information supplied to DIPNR by Bishop Austrans Pty Ltd).


Austrans Prototype demonstration (Photos by PB)

While the Austrans system claims several ground-breaking innovations, the system has not been demonstrated in revenue service. Consequently, the system can not be evaluated based on its performance in similar applications.