
# PARRAMATTA ROAD PUBLIC TRANSPORT OPPORTUNITIES STUDY

**TRANSFORMING PARRAMATTA ROAD**

INNER WEST COUNCIL

City of Canada Bay

**Bodhi Alliance Pty Ltd**
**EDAB Consulting Pty Ltd**
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# Abstract

This Study was undertaken for the Inner West Council and City of Canada Bay (**Councils**). It identifies the various constraints, benefits and opportunities of providing a dedicated enhanced public transport system along Parramatta Road between Sydney CBD and Strathfield. Its broader application throughout Sydney's inner west and the needs of this community was also considered. It is reflective of market dynamics, community need, infrastructure delivery and government policy.

This Study is intended to support Councils' proactive advocacy for a public transport system that will enable realisation of the vision for Parramatta Road as a place for people, a high quality multi-use corridor - *"**a living street: a corridor of enterprise**"*[1].

Of note this Study recognises:

> *Sydney is one of the world's great cities. While we will draw on international trends to foster innovation and transition… we also believe the city can be a leader in this transition* (Urban Growth for NSW).

An opportunity has been identified whereby **Sydney can assume a leadership role in public transport**. By progressing beyond the well-proven and well-accepted advantages of light rail and harnessing proven and rapidly developing technologies to provide a rapid transit system along key transport corridors. The greater Sydney urban region offers great potential for such a system. This would best serve the commitment to improving public transport to enable urban transformation – making a great city more vibrant and sustainable. This can be achieved at much lesser cost and be implemented quicker than light rail. It also offers greater flexibility in terms of extending beyond the key transport corridors so creating a truly integrated public transport network. It has been termed 'Guided Electric Transit System' (GETS) –adopted for convenience of reference**. It is best considered as a solution that promotes the concept of 'rapid transit corridors' using best available and most cost-effective technologies.**

[1] WestConnex Urban Renewal Framework Hassell 2013

# Notes

1) In essence this Study was a progression of the Parramatta Road Urban Transformation Strategy as prepared by Urban Growth NSW. Consequently amongst the Study's key references was the Draft Parramatta Road Urban Transformation Strategy (September 2015 Volume 1) and its supplementary information. However, at the time of finalising this Study the Parramatta Road Transformation Strategy was released in final form.

Whilst this Study remains broadly consistent with the final form of the Strategy there are some key points of difference. In particular the final Strategy subtly but significantly minimises the place function of Parramatta Road itself and no longer envisages Parramatta Road as- ***"a living street: a corridor of enterprise"*** but more simply as a high quality multi-use corridor - ***as a State Arterial Road***.

The tension between the vision and intent is addressed in the Study. That is, the tension between place and movement is addressed by identifying the opportunity for a high quality public transport system to support transformation as originally envisaged, so returning Parramatta Road to being a vibrant high road.

2) Subsequent to completion of the initial Study additional research was undertaken. This concerned a comparative analysis of the Rapid Bus Service (RBS) and the Guided Electric Transit Service (GETS). The RBS is that currently proposed by the NSW Government through its Agencies and the GETS is that identified in the initial Study as an alternative (to Light Rail and the RBS) worthy of further more detailed investigation.

The additional research is detailed in an **ANNEXURE** to the Study Report.

## EXECUTIVE SUMMARY

A Study to identify the various constraints, benefits and opportunities of providing light rail along Parramatta Road (between Sydney CBD and Strathfield) was undertaken for the Inner West Council and City of Canada Bay. The particular focus of the Study was on progressing the urban transformation of Parramatta Road within the Inner West area of Sydney.

A review of previous Studies revealed that the need to improve Parramatta Road is well recognised. Also, that there is agreement for improvement to be achieved primarily through increased **emphasis on the public realm** inclusive of a high quality dedicated public transport system along Parramatta Road. In this regard (based on a consideration of world best practice) investment in an **appropriate public transport system** is a well-proven **catalyst** for urban transformation.

The catalytic effect results from the provision of a dedicated appropriate public transport system conveying a strong sense of long-term commitment by virtue of its designated route and associated station infrastructure. It is perceived as being more permanent than low-order bus services which can be readily rerouted or curtailed. This translates into confidence by the community and investors.

There is a somewhat long-lived and wide-held view that only light rail can achieve the desired catalytic effect. However, recent research has identified that it is not light rail per se that is required for urban transformation. Rather it is the integration of a dedicated public transport system with other modes and a quality public realm that incentivises walking and cycling and so provides the optimal social and economic return on investment.

It is the case that light rail has significantly greater passenger moving capacity than for low-order bus services. However, passenger moving capacity is neither the sole nor prime performance criteria relevant to urban transformation. For the transformation of Parramatta Road there are various performance criteria relating to selection of an appropriate public transport system. Key amongst these is the frequency of service such that it enables and so encourages passenger movement along Parramatta Road to reactivate the nominated precincts. The movement of large numbers of passengers from out-lying residential areas and from those in the vicinity of Parramatta Road to and from the Sydney CBD is more the role of the existing heavy passenger rail service.

There is potentially significant property value uplift associated with the provision of dedicated public transport infrastructure as compared to low-order bus services. The Parramatta Road Transformation Strategy envisages this value uplift. It outlines maximum density and height along the corridor and requires Councils to deliver plans in line with the Strategy. The provision of dedicated public transport infrastructure along Parramatta Road will incentivise development through value uplift.

A **two-way light rail** can be accommodated along Parramatta Road. However, the road reserve width does vary such that for the majority of the route there would need to be adoption of minimal traffic/parking lane widths and in some instances reduction of footpath width to accommodate light rail. A dedicated public transport infrastructure route inclusive of station locations and 'loops' to link with the Heavy Rail Passenger Stations at Burwood and Strathfield Stations has been developed. It provides a basis for further more detailed investigation.

A comparison of kerb-side and centre-running configurations was conducted. Whilst both are feasible it was determined that **centre-running** is preferred. It has the significant advantage of enabling the kerb-side traffic lane to be managed for short-term parking in support of the substantial current and future potential businesses whose premises have street-frontages along Parramatta Road. It could also be managed during peak demand periods for vehicular traffic though this would not be ideal as it would be inconsistent with the intended urban transformation of the various nominated precincts along Parramatta Road.

The Study primarily focussed on comparative advantages of the dedicated public transport systems of light rail and bus rapid transit. It also included consideration of alternative forms of public transport. The Study found that newer proven transport technologies are available, that are currently being considered for several 'world cities', that have the capability to provide a viable public transport system that could deliver the same benefits as light rail at a significantly lower cost. The integrated suite of these technologies are described in this Study and referred to as a Guided Electric Transit System **(GETS)**. Key features of a GETS include on-route quick charge electric vehicles with intelligent guidance. It was determined that a GETS is well suited to Parramatta Road.

The technologies underpinning a GETS are well-proven. These are relatively new and rapidly advancing. **Understandably then a GETS is not yet widely understood and accepted as compared to light rail**. A GETS does offer advantages over the existing bus and prospective light rail service. These being:

- The intelligent guidance of a GETS (not rail or kerb guidance) provides improved safety and passenger comfort and also allows the vehicles to run in a narrow corridor.
- In the longer term a GETS could be used to support an extended 'Spine and Spur' network to locations including Concord Shops, Concord Hospital, Rhodes, Wentworth Park, Olympic Park, and Five Dock.
- A GETS would provide investor and broader community confidence through the provision of infrastructure (stations/platforms) and a state-of the-art fleet.
- The vehicles of a GETS have narrower width requirements as compared to light rail so making centre-running more feasible and creating opportunities for the kerbside parking that is much needed for the reactivation of street frontage uses along Parramatta Road.
- A GETS does not require rails, nor electric wiring along its route (in-ground or overhead and associated pantograph) and so a centre-running GETS service using prefabricated platforms could readily be introduced within the Parramatta Road corridor in a relatively short period of time. If timely decisions are made a suitable system could be introduced to coincide with the 'Day-One' opening of WestConnex Stage 3 Part 1.
- Network resilience with regard to capability to deviate travel course - as required by reason of accident/incident or temporary work-sites and greater flexibility to adapt to changes in demand or technology.

Rather than lock-in old technologies it is suggested that Sydney takes the lead providing an innovative integrated land-use and transport solution for the Inner West. For Parramatta Road and the associated adjoining areas there is a real opportunity for capitalising on recent advancements in Intelligent Transport Systems (ITS), electric vehicles, vehicle intelligence and energy storage to select a tailored system based on emerging proven technology.

The GETS is a transport solution that is affordable, adaptable and has minimal construction impacts making it the most suited to inner City growth and revitalisation. It is a solution that is aligned with Government policy and particularly with the vision and direction articulated in A Plan for Growing Sydney, the Draft District Central Plan and Future Transport Technology Roadmap. The Roadmap aims ***to put NSW at the forefront of adopting emerging transport technologies, unlock value in the system and customise and personalise transport services for customers across the state.***

It is the advantage of 'immediate' implementation afforded by a GETS solution that is particularly relevant. This is an important criterion given that:

- it is possible to make immediate changes to Parramatta Road consistent with the urban transformation strategy – high-street reactivation at designated precincts
- imperative to 'arrest' deterioration, particularly of heritage buildings – with 'demolition by neglect' evident
- a staged implementation is both possible and practical – with the more substantial changes occurring in-synch with the WestConnex delivery program
- opportunity for implementation on ***'Day-One'*** (concurrent with opening of Stage 3, Part 1 of WestConnex; the M4-M5 Link tunnel).

This approach would also serve to clearly signal to the broader community that a fundamentally different and better scenario for the future development and use of Parramatta Road is being created. It is imperative that this scenario be activated 'immediately' and not be delayed until completion of WestConnex in 2023.

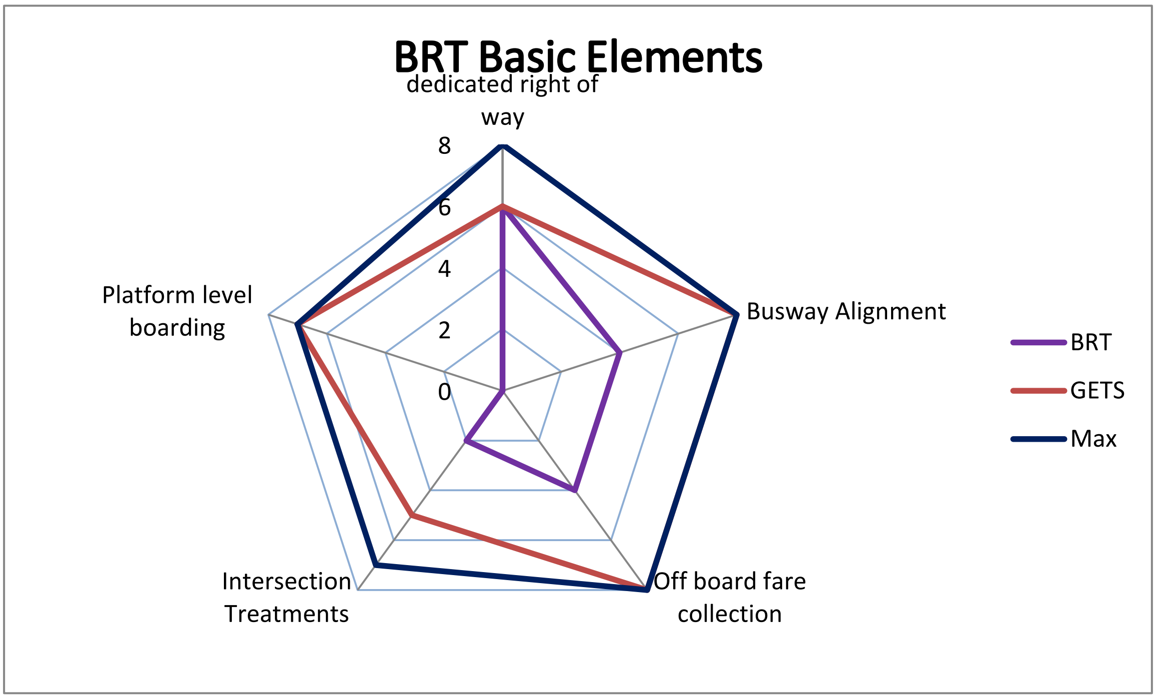
So whilst light rail is a feasible option to improve public transport along Parramatta Road there are limitations and risks relating to cost and timing of implementation. The risks relating to technological and social changes that are readily apparent are not consistent with there being long term benefits of light rail. It is considered that the mode shift, transport benefits and the impetus for urban transformation would be achieved sooner and at substantially lower cost through a GETS solution.

The GETS was also determined to be preferable to the Rapid Bus Service (RBS) currently proposed by the NSW Government through its Agencies. The comparative analysis underpinning this conclusion is presented in an **ANNEXURE** to the initial Study Report.

The comparison of the RBS and GETS options presented in the Annexure was undertaken utilising the Institute for Transportation and Development Policy (ITDP) International Standard and associated rating Scorecard for rapid transit public transport systems. It is noted that use of the Standard and Scorecard was determined to be highly relevant especially given there is a strong link between rapid transit and urban transformation in terms of increases to property values and economic development in, along and adjacent to the corridor of operation (as identified in an international study for Infrastructure Australia in 2013).

Bus Rapid Transit as defined in the ITDP Standard is a road-based rapid transit system that can achieve high capacity, speed, and service quality at relatively low cost by combining segregated lanes that are typically median aligned with off-board fare collection, level boarding, vehicle priority at intersections, and other quality-of-service elements (such as information technology and strong branding). The ITDP Standard is applicable to the RBS (of the PRCUT Strategy) and the GETS identified in the Study.

The additional ITDP based comparison served to identify that the RBS as currently proposed by the NSW Government does not meet the basic requirements for a Bus Rapid Transit system as compared to the GETS which is rated as being of an advanced level.




It is noted that the ultimate form of RBS proposed for the Parramatta Road Corridor may differ slightly from that assumed in this comparison. Nonetheless the comparison conducted does provide insight into the potential impacts of various options and associated elements of the design, construction and operation of a public transport system along Parramatta Road.

In that regard, this comparison incorporates consideration of the rationale implicit in the proposed RBS and determined it to be a significant departure from that required to effect the urban transformation of the Parramatta Road Corridor. That is, the form and timing of implementation of an improved public transport system is vital to achieve the desired transformation of the Parramatta Road Corridor. There is a need at the earliest opportunity to ‘claim and preserve’ from ‘Day One’ the Parramatta Road Corridor for enhanced provision of public transport - in-synch with the delivery program and consistent with the prime purpose of WestConnex. This would serve to preclude the leakage of private commuter car use back onto Parramatta Road (in response to tolls) and the inevitable latent traffic demand. The GETS offers (amongst many advantages compared to the proposed RBS and Light Rail) a readily manageable implementation timeline – ‘immediate’ and scalable.

**This Study recommends**:

- Preservation of the public transport corridor (in Parramatta Road) for a Guided Electric Transit System (GETS) with the option of incremental upgrades in capacity by increasing the frequency of service (by adding additional vehicles) as demand increases.
- Centre-Running vehicles from 'Day-One' of WestConnex Stage 3, Part 1.
- Provision of short-term kerbside parking outside of peak periods.
- Pursuing opportunities for a future 'spine and spur' network with first and last mile infrastructure as identified in the TfNSW Roadmap 2016.
- The relevant Councils to work collaboratively with State and Federal Governments to progress the project. Initially this would involve more detailed investigations that collectively would comprise a Feasibility Study. Of note through this Opportunities Study the relevant Councils now have a well-informed basis to productively contribute in a collaborative partnership with State and Federal Governments.

**Next steps**

The preferred next step in this project would be the establishment of a collaborative approach between all levels of government to progress a Feasibility Study. This would provide a detailed assessment of the viability of a Guided Electric Transit System (GETS) for Parramatta Road capable of being introduced to coincide with the opening of WestConnex Stage 3 Part 1 (if approved). Also of it being configured for centre-running and providing kerbside parking (at least outside of peak periods). Consideration should also be given to arrangements that would enable (as required) for the new GETS to support the short-term inclusion of existing buses running in a mixed traffic environment.

**The basis for such a productive collaborative approach is a comprehensive and shared understanding of a GETS.** It is apparent that this has not yet been achieved and to this end a series of briefings of the decision-makers and other key stakeholders is an imperative pre-requisite step. Such briefings could usefully incorporate intelligence gathering visits to other jurisdictions in the form of a public-private joint technical tour.

This Study is cognisant of significant recent commitments made to invest in light rail in the Sydney urban region and has considered the importance of an integrated network. It has also given consideration to the staging, development and cost impacts of retrofitting light rail in an urban environment. The system agility and opportunities presented by the very recent technology advancements should not be ignored. **With emerging technology there is a state of flux and this should be 'embraced and shaped' to provide the best of advantages to current and future generations of Sydney.**

In the language of the Roadmap the GETS provides opportunity for putting in place **'<u>no regrets</u>'** technology and infrastructure. Thus reserving the corridor and the agility to respond to change and accommodate future uses be that light rail or other transport innovations.

# 1. INTRODUCTION


This Study identifies the various constraints, benefits and opportunities of providing a dedicated enhanced public transport system along Parramatta Road between Sydney CBD and Strathfield with potential links to Inner West strategic centres – Burwood, Rhodes and Olympic Park. It is reflective of market dynamics, community need, infrastructure delivery and government policy.

Undertaken for the Inner West and City of Canada Bay Local Government Councils the Study is intended to support Councils' proactive advocacy for a public transport system that will enable realisation of the vision for Parramatta Road as a place for people, a high quality multi-use corridor - ***"a living street: a corridor of enterprise"***[2].

It is envisaged that the transformation of Parramatta Road will occur over a 30-year timeframe and this will require sustained support from the NSW Government, Local Government, the private sector and community over the long-term. It will also need to be agile, undertaken in such a way that creates and preserves options so that the best outcomes can be achieved at all times throughout the transformation.

With the development of WestConnex and the NSW State Government commitment to the renewal of Parramatta Road as a key outcome there is a window of opportunity to realise the vision for Parramatta Road. The vision being for Parramatta Road to be a high quality multi-use corridor, with high amenity and balanced growth of housing and jobs *"a living street: a corridor of enterprise"*. In large part it is dependent upon improved public transport and encouraging walking and cycling.

Timing is critical and with works for WestConnex advancing and the release[3] of the Parramatta Road Transformation Strategy, this Study reviews the opportunities for leading infrastructure that will catalyse development in support of the vision through the provision of appropriate alternative high street suited public transport.

The vision for Parramatta Road is clearly articulated in the Parramatta Road Urban Transformation Strategy (PRUTS) and Sydney CBD to Parramatta Strategic Transport Plan. The PRUTS and the associated 5 year implementation plan concern integration of land use, redevelopment and infrastructure to achieve the vision in a staged manner. The Sydney CBD to Parramatta Strategic Transport Plan sets out the strategic context for the 22-

[2] WestConnex Urban Renewal Framework Hassell 2013

[3] Parramatta Road Urban Transformation Strategy (PRUTS) and supporting documentation was released on 9thNovember 2016 in final version (as distinct from the Draft version used throughout this Study). Whilst this Study is broadly consistent with the final version of the PRUTS there are key points of difference. These are presented in a separate Annexure to this Study Report.

kilometre corridor between the two CBDs. It is primarily focused on transport and land use outcomes and how people move within and around the Corridor[4][i].

## The Case for Change

The case for change was well stated in the 2013 Parramatta Road: WestConnex Urban Renewal Framework prepared by Hassell for the Sydney Motorways Corporation.

> *Parramatta Road is in a state of profound environmental, economic and urban decline. For arguably 50 years, the road has progressively deteriorated under the pressure of burgeoning traffic volumes to a state where, today, it is no longer possible to engage in conversation on the footpath, where noise and air quality is below WHO guidelines, where local citizens rarely cross the street to access a shop or meet a friend and where few businesses trade beyond 9-5.*
>
> *The vibrant, local communities of Concord, Petersham and Leichhardt that emerged during the inter-war years and prospered through the 1950's and 1960's as families made their life in the inner west, have gone. These young communities once used Parramatta Road as their high street. People walked to and from Parramatta Road - to work, to shop, to go the movies or a dance. …*
>
> *As the appearance and amenity of Australia's oldest street has waned so has its economy. Land values are now depressed, productivity is low, many sites are vacant and there is little night time activity.*
>
> ***Parramatta Road today is a street without vibrant economic or social life and without a soul. It is a non-place.***

*Figure 1 Commercial Vacancies Parramatta Road*

[4] Both Sydney and Parramatta CBDs are subject to separate transport and land use investigations.

# 2. CONTEXT


**Policy and Planning Context**

Since 1998 there have been several studies that address the transformation of Parramatta Road. These studies all recognise the issues and opportunities and share a common vision and rationale for the upgrading of the Parramatta Road Corridor. Key policies and initiatives influencing the development for Parramatta Road have informed this Study – including A Plan for Growing Sydney, the Draft Central District Plan the Sydney CBD to Parramatta Strategic Transport Plan, Parramatta Road Urban Transformation Strategy and the WestConnex. Additionally the impact of the CBD and South East Light Rail has also been considered.

**A Plan for Growing Sydney** (December 2014)
A Plan for Growing Sydney is the NSW Government's plan for the future of the Sydney Metropolitan Area over the next 20 years. The Plan provides key directions and actions to guide Sydney's productivity, environmental management, and liveability – including the delivery of housing, employment, infrastructure and open space. It enunciates the Government's vision for Sydney as: *a strong global city, a great place to live*.

To achieve this vision, the Government has set down goals that Sydney will be:

- a competitive economy with world-class services and transport;
- a city of housing choice with homes that meet our needs and lifestyles;
- a great place to live with communities that are strong, healthy and well connected; and
- a sustainable and resilient city that protects the natural environment and has a balanced approach to the use of land and resources.

The Plan for Growing Sydney sets out actions that will deliver these goals for Sydney. Each goal has a number of priority areas (directions which provide a focus for the actions). The actions include:

- accelerating urban renewal across Sydney at train stations, providing homes closer to jobs;
- growing a more internationally competitive Sydney CBD;
- growing Greater Parramatta as Sydney's second CBD;
- transforming the productivity of Western Sydney through growth and investment;
- enhancing capacity at Sydney's Gateways – Port Botany, Sydney Airport and Badgerys Creek Airport;
- delivering the infrastructure that is needed;

- promoting Sydney's arts and culture, tourism and entertainment industries;
- protecting our natural environment; and
- managing long-term growth.

The Plan for Growing Sydney will be delivered by the Greater Sydney Commission.
The map below indicates the relevance for Parramatta Road the hierarchy of centres the 2 CBD Parramatta and Sydney and Strategic Centres of Burwood, Olympic Park and Rhodes, the blue the urban renewal corridors and yellow economic corridor.

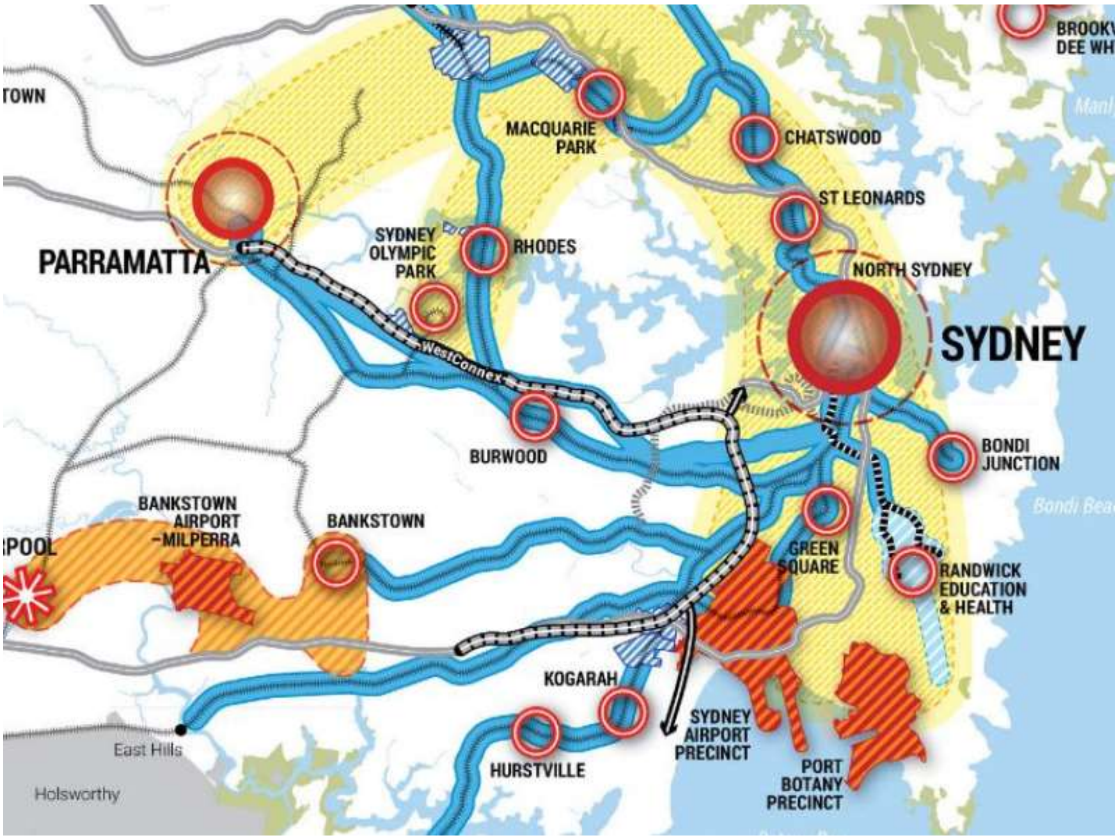



*Figure 2 Source: A Plan for Growing Sydney 2014*

**Draft Central District Plan** (November 2016)
Draft Central District Plan identifies Parramatta Road as a strategically important transport route for business, employment and urban services. The strategy is focused on providing *committed and planned infrastructure* to increase access to places within 30 minutes through transport improvements including Sydney Metro northwest and Sydney Metro city, Sydney Metro West and Southwest, CBD and South East Light Rail and WestConnex.

*Towards our Greater Sydney 2056* captures an ambitious future for a growing Greater Sydney and acts as a bridge between the current and future metropolitan plans that provide the overarching vision for Greater Sydney as a whole. It describes Sydney as *A Productive Greater Sydney*; a city with more jobs in many centres with more people being able to access their jobs within 30 minutes of where they live.

The plan sets out priorities and actions to shape the District's future and guide policy decisions to achieve the vision for the Central District. This includes '*leveraging investment in transport infrastructure*' to increase connectivity between where we work, live and play with improvements to mass transit, cycling and walking routes. Improved connectivity will help in revitalising the employment, cultural and housing opportunities along the growth corridors and precincts. The plan also focuses on *'improving freight, logistical and urban services'* to address the conflicts between housing areas and freight traffic. Parramatta Road has served as a major thoroughfare for trade and traffic since the eighteenth century. Investment such as a dedicated Parramatta Road public transport route presents opportunity to improve the way goods, services and people are moved in the District.

**Parramatta Road Urban Transformation Strategy** (November 2016)

- 30 year vision
- 56,000 additional people
- 27,000 homes and 50,000 jobs
- $31bn of development value

PRUTS consists of two sections- Eastern and Western corridor. The Parramatta Road light rail is focused on the eastern section of the corridor which runs from Homebush to Camperdown, encompassing lands in the Strathfield, Burwood, Canada Bay, Inner West and City of Sydney LGA's. The eastern section of the corridor with development focused in these five precincts, aim to deliver up to 42,900 people in 20,600 new homes and provide 29,250 new jobs. This indicates that more than 75% of the proposed development is focused around the eastern section of the corridor.

PRUTS relies on investment in public transport around the corridor to improve accessibility and quality of urban environment on Parramatta Road to restore the <u>vibrancy and re-establish the businesses along the frontage</u> (PRUTS, p.30). In particular, <u>Parramatta Road of tomorrow is envisioned to be highly *accessible and connected*</u>:

1. It is easier to move to, through and within the Corridor in both east-west and north-south directions.
2. The urban transformation of the Corridor is supported by transit-oriented development. Existing and new desirable and affordable mixed use environments are enhanced by high-quality, high frequency public transport and safe active transport connections.
3. Available road and rail capacity is utilised and public investments in transport are optimised.
4. Non-infrastructure initiatives, such as encouraging visitors to use non-car modes of travel to help alleviate congestion, and modifying or altering timing of trips, are well utilised.
5. People choose to walk and/or cycle for local trips along the Corridor’s 34km of new and upgraded links, hop on buses and/or light rail for intermediate trips, and use rail and/or car for regional trips.
6. The integrated transport network contributes to regional resilience and sustainable communities along the Corridor and beyond.

This Parramatta Road Light Rail Opportunities Study reinforces the vision of PRUTS to improve accessibility and connectivity of Parramatta Road by proposing an efficient public transport system which can reduce the private car dependence and improve the sustainability and resilience of Parramatta Road.

The Strategy will be implemented in two stages, 2016 – 2023 and post 2023. Land use change prior to 2023 will be guided by the *Parramatta Road Corridor Implementation Plan 2016 – 2023* and will be accommodated with planned improvements to Western Line rail frequencies and a rapid bus solution from Burwood to Sydney. Investment such as longer term light rail or heavy rail solutions, currently being investigated, would be required to support the land use change beyond 2023. The short term staged approach will allow for the land use change to move in sync with the available transport capacity, whilst ensuring the scale, timing, and staging of longer term land use changes respond to Government transport investment.

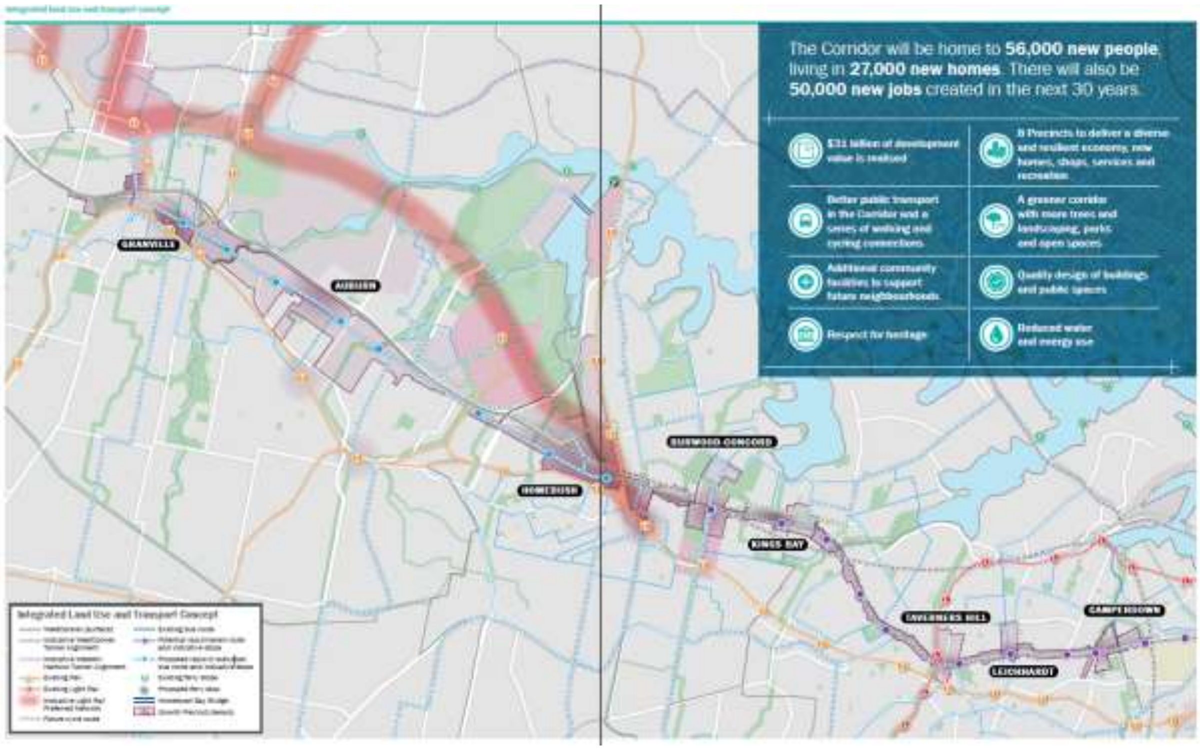



*Figure 3 Integrated Land Use and Transport Concept 2016*

### Draft Parramatta Road Urban Transformation Strategy 2015

The draft Parramatta Road Urban Transformation Strategy (PRUTS) was the document that primarily informed this Study as the above documents were released in November 2016 just as the Study was being finalised. The key differences from the Draft Strategy are the reduced housing targets (final Strategy to 27,000 from 40,000 in the Draft). It also has less emphasis on the place role of Parramatta Road itself with greater detail on this role within the Precincts.

The Draft PRUTS was prepared by Urban Growth NSW in collaboration with local Councils aimed to deliver:

- up to 70,000 people in 40,000 new homes

- up to $28bn total development value over 20 years, bringing significant economic benefits to the state
- a productive business environment to support viable and prosperous businesses, with land for up to 50,000 new jobs over 30 years
- eight precincts will accommodate a diversity of land uses and densities, supported by a range of active and public transport
- an integrated and legible network of open space and pathways to encourage pedestrian and cycle activity

The PRUTS suggested that kerbside Bus Rapid Transit (BRT) was a suitable transport option for the corridor and identified potential stops at precinct locations.

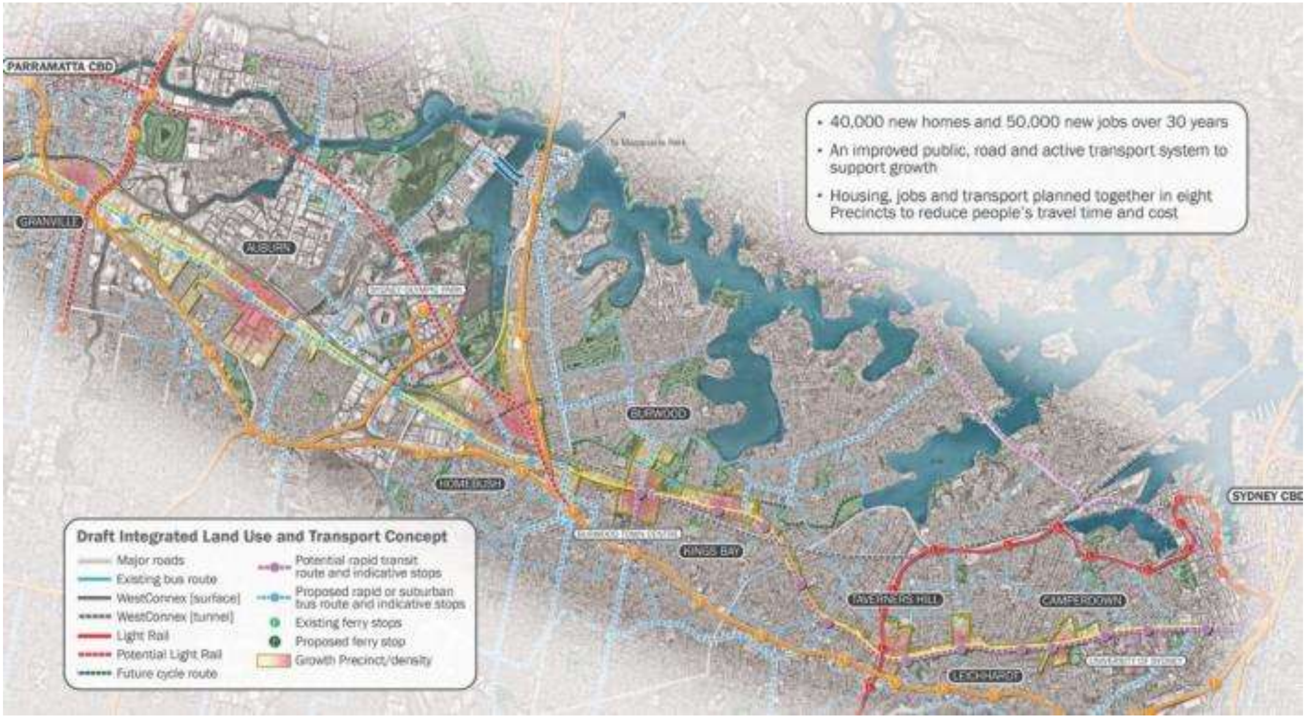



*Figure 4 source Draft Parramatta Road Urban Transformation Strategy 2015*

## WestConnex and Parramatta Road

The reconstruction of Parramatta Road and urban renewal along the corridor is a fundamental NSW Government stated outcome of the WestConnex project. WestConnex is a 33 kilometre motorway linking Sydney's west and south-west with Sydney Airport and the Port Botany precinct. The WestConnex motorway project has a capacity for up to 150,000 vehicles per day and will provide access via motorway and tunnel from Parramatta to Beverly Hills via Strathfield, Haberfield, Rozelle and St Peters. One of the stated benefits of the motorway is to reduce traffic volume, noise and pollution along Parramatta Road and provide the opportunity to return Parramatta Road to its former function as a 'high-street', thus unlocking the potential for urban regeneration throughout the inner west.

Roads and Maritime Services (RMS) propose to construct and operate the M4-M5 Link which would comprise a new, tolled multi-lane road link connecting the M4 East at Haberfield with the New M5 at St Peters. The project is a component of the WestConnex program and will likely include interchanges at Rozelle and Camperdown[5].

The NSW Government is using a limited recourse financing model for the WestConnex project. Private sector debt finance and a loan from the Federal Government will be raised against future toll revenue to fund a significant portion of the construction costs.
Under this model, it is also possible to implement private sector financing during or after construction. The State will then sell down the equity it has invested into the project and recycle the proceeds into Stage 3 of the project.
The State has established a special-purpose vehicle, Sydney Motorway Corporation, to deliver the project on behalf of the client, Roads and Maritime Services.

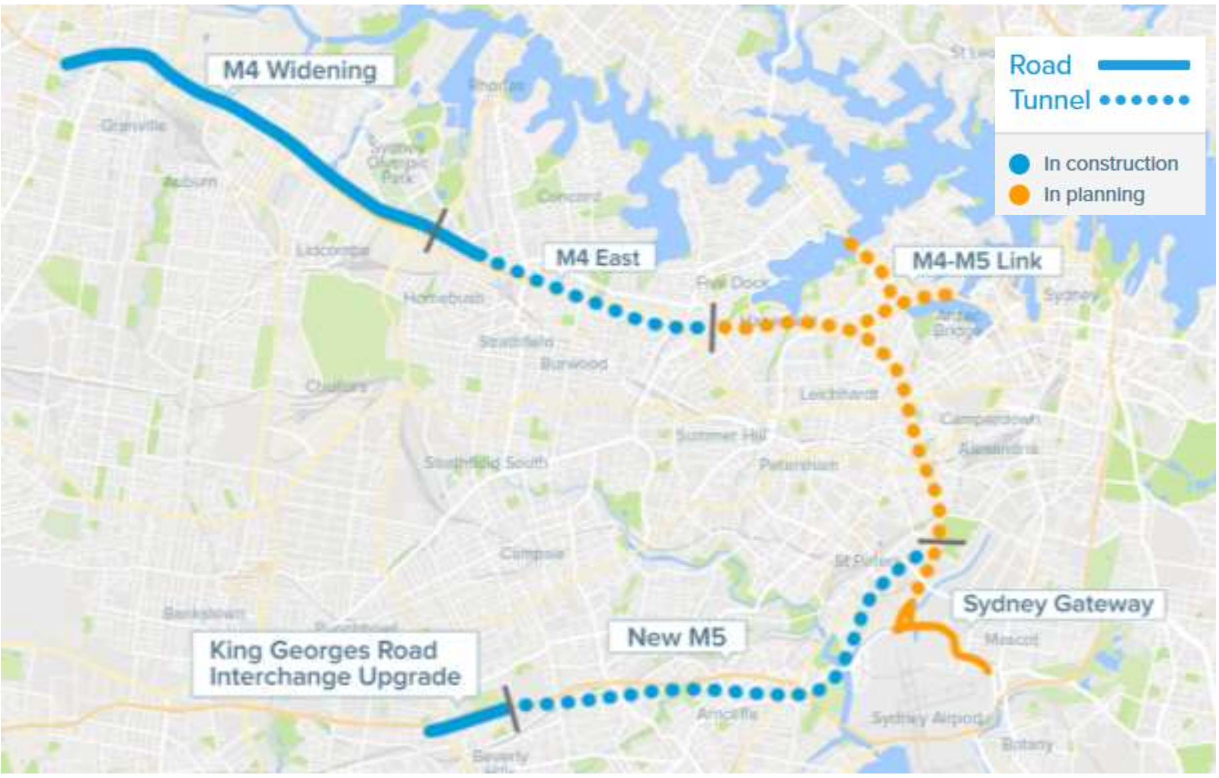



*Figure 5 WestConnex Projects map*

**Sydney CBD to Parramatta Strategic Transport Plan 2015**

The Sydney CBD to Parramatta Strategic Transport Plan sets out the strategic context for the 22-kilometre corridor that runs between the Sydney CBD and Parramatta CBD, as well as land between these two centres up to Victoria Road in the north and the T3 Bankstown Line in the south. As both CBDs are subject to separate transport and land use investigations, this Plan is primarily focused on transport and land use outcomes between the two CBDs and how people move within and around the Corridor.

The Plan brings together current strategies, proposals and interventions, integrating how the land will be used in the future, what connections are required, and how growth and

[5] The plans for the interchanges at Rozelle and Camperdown are provided in Appendix C. It is noted though that it has very recently been advised that the Camperdown interchange is not to proceed.

transformation within the Corridor can be balanced against local, regional and metropolitan requirements for transport, housing and employment.

It focuses on the Corridor as a whole, rather than specific transport modes, individual projects or particular neighbourhoods or suburbs. This broader scope seeks to provide a holistic understanding of current and future conditions, limitations and proposed initiatives to meet the overall aim of achieving accessible and liveable centres and communities.

Transport for NSW and the Roads and Maritime Service are responsible for the delivery of the Sydney CBD to Parramatta Strategic Transport Plan. The plan identifies that current demands within the Corridor can be enhanced through actions that address trips and travel modes:

- Local trips can be made, in general, on foot or by bicycle
- Intermediate trips will continue to comprise the majority of trips within the Corridor and, if supported by appropriate land uses, represent a key opportunity to enhance the capacity and efficiency of the transport network without necessarily requiring significant new infrastructure investments. Bus priority measures and potentially Bus Rapid Transit (BRT) were suggested initiatives for Parramatta Road
- Regional trips through the Corridor can be made by regional rail and in the future via WestConnex.

## The CBD and South East Light Rail

The CBD and South East Light Rail combined with a redesign of city centre buses will mean 220 fewer buses travelling into the city centre in the morning peak's busiest hour, relieving surface congestion. The Sydney Metro (North West Rail Link) will further contribute to a reduction in buses with some 160 fewer buses entering the city centre.

## Sydney's Bus Future

The focus of Sydney's Bus Future is to integrate transport modes and makes the role of buses in the public transport network simpler and easier to understand. A clear, three-tiered network will operate with each level delivering a defined level of service consistency and reliability. Rapid service routes form the backbone of the new bus network, offering fast, reliable bus travel for customers between major centres. Rapid routes provide customers with mass transit level services between centres which are not linked by trains or light rail. Suburban service routes and Local service routes build on this foundation to improve access to local, neighbourhood destinations.

Across metropolitan Sydney, 13 Rapid bus routes will operate and 20 Suburban routes have also been confirmed, with more to be added. With these changes, over 1.5 million Sydneysiders will live within a 10 minute walk of a Rapid or Suburban bus service – meaning access to 'turn up and go' services, 7 days a week. Half of these customers will live within a 10 minute walk of the Rapid network, connecting major centres at least as often as every 10 minutes 6am to 7pm Monday to Friday and every 15 minutes on the weekend.

The process of streamlining bus services will be completed progressively across Sydney. To ensure the most responsive and flexible bus network is being offered, all services will be continually monitored and changes introduced to meet customer travel needs.

A staged approach will be taken to introducing BRT on targeted Rapid service routes. In the long term, it may be possible to convert Rapid routes to light rail in areas with high growth and density. Key high growth corridors to be investigated for BRT or light rail include:

- Parramatta Road
- Victoria Road
- Anzac Parade between Kingsford and Maroubra or Malabar
- Northern Beaches
- Proposed Western Sydney Light Rail Network.

### Sydney's Heavy Rail

The Minister for Transport Andrew Constance announced in December 2016 that $1.5b has been committed to improve capacity and service of Sydney's rail network. The program 'More Trains, More Services' aims to address the forecast 21% growth in patronage over the next 5 years. It will provide:

- 24 new eight-car Waratah-style trains to be delivered by late 2018.
- New express services on the T1 Western Line.
- Upgraded track, signalling and power to increase capacity and reliability.
- 4 extra express trains between Parramatta and the Sydney CBD
- Train services every 3 minutes, or up to 20 trains per hour in the busiest periods.
- A new timetable to implement the extra services on the T1 Western Line

'More Trains, More Services' is be a staged program of works on the rail system to compliment additional rail capacity being introduced on the network, particularly the Sydney Metro Northwest line which is due to open in 2019.


*Figure 6: Sydney West Metro Route (source TfNSW)*

Also announced in November 2016 was the Government commitment to a new underground metro railway for Western Sydney. The Sydney Metro West will provide a direct connection between the CBDs of Parramatta and Sydney. As can be seen from the route map taken from the TfNSW project website the route is still very conceptual.

"A metro line in Western Sydney will effectively double rail capacity between Parramatta and the Sydney CBD, transforming the way we get around our city forever."[6]

The NSW Government will work with the community and industry to deliver the project, including new railway stations at:

[6] Andrew Constance quoted http://www.transport.nsw.gov.au/newsroom/media-releases/sydney-metro-west-new-railway-more-trains-western-sydney

- Parramatta, where the number of jobs is expected to double over the next 20 years to 100,000
- Sydney Olympic Park, where 34,000 jobs and more than 23,000 residents will be located by 2030
- The Bays Precinct, Sydney's new innovation hub where 95 hectares of land is being regenerated
- Sydney CBD, allowing easy access to the existing public transport network and Stages 1 and 2 of Sydney Metro, which is currently under construction.

The new service will have capacity for 40,000 people an hour in each direction and is expected to be built largely underground and be operational in the second half of the 2020s.

The NSW Government will investigate innovative ways to reduce travel times between the two CBDs as well as the final number of stations needed to service communities along the route. Other potential stations along the route will be determined through consultation with industry and the community.

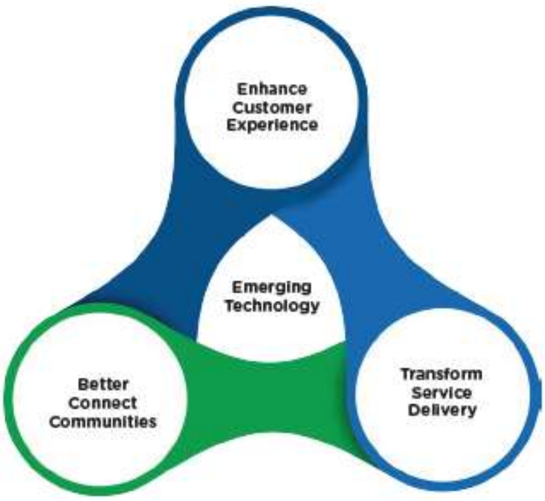
The development of Sydney Metro West will use a market-led approach to deliver value for money for taxpayers. The final cost of the project will be determined following engagement with industry and the development of a business case.

Sydney Metro West will integrate with long-term transport planning for Western Sydney including Parramatta Light Rail, the rail needs currently being investigated for the future Western Sydney Airport and the Western Sydney Rail Upgrade Program targeting capacity on the T1 Western Line.

**Future Transport Technology - Roadmap 2016** (November 2016)

An initiative of the NSW state government and Transport for NSW the Future Transport Technology Roadmap 2016 (Roadmap) identifies 12 emerging and developing fields of technology that will transform transport as they mature, interact and converge over the next 10 to 20 years. Transport for NSW has developed this Roadmap with the aim to put NSW at the forefront of adopting these technologies, unlock value in the system and customise and personalise transport services for customers across the state.

The adjacent diagram shows the relationship between transport goals and emerging technology.




The Roadmap presents four potential scenarios that may emerge over the next two decades as the uptake of transformative technologies changes and disrupts consumer behaviour. To accommodate the range of possibilities that may arise, a flexible strategic framework and Roadmap will be implemented to transform service delivery, better connect communities and enhance the customer experience as these technologies mature.

The current suite of Transport Plans will be rewritten in 2017 to reflect the intent of the Roadmap.

Five strategies will be executed with the aim of shaping the most customer-centric, innovative, digitally-enabled transportation system in Australia. By incubating new uses, and trialling and adopting new, world- class technologies as they emerge, Transport for NSW will:

- Develop and connect real-time digital information, navigation, payment and engagement platforms so they are simpler to understand, easier to use and can give personalised services relevant to individual needs and preferences.
- Transform mass transit networks to improve their efficiency, deliver better service frequency and reduce transit times, increasing the attractiveness of these services for customers.
- Foster shared, demand-responsive services to offer customers a greater variety of mobility options and flexibility of choice that matches their particular needs.
- Pursue national standards for the road infrastructure, systems and regulatory frameworks needed to adopt greater levels of vehicle automation earlier, and identify how best to deliver community benefits that autonomous vehicles will bring.
- Create intelligent transport networks, managed with data that enable increasingly efficient, flexible and dynamic service delivery with improved safety, availability, reliability and responsiveness.

The significance of this Roadmap for this report is the Government commitment to responding to change and adoption and trialling of new technology. Of relevance also is the first and last mile transport options bike and car share and autonomous pods, and electric public transport vehicles and on route charging.

**Overall**

It is apparent from the Planning and Policy context outlined above that the transformation of Parramatta Road requires an appropriate dedicated public transport system. As such this Study is a progression of state government aspirations for urban growth and regeneration through the integration of transport and land-use.

# 3. URBAN TRANSFORMATION


## 3.1 Concept and Characteristics

**Urban transformation** is the renewal of degraded or underutilised areas of a city. It considers how large areas can be transformed into productive and vibrant precincts, planning and managing growth so that the Corridor can re/attain its diverse and distinctive identity.

**Urban transformation** seeks to:

- Align where people live, work and how they get around with the structure of the economy, achieving world-class outcomes
- Locate homes close to jobs and expansive transport systems: contributing to productivity and quality of life, and therefore prosperity
- Link workers and employers and businesses, increasing productivity and national prosperity and attracting global talent and international organisations
- Foster creativity and happiness, setting a city structure that aims to lessen time in traffic, encourages walking and cycling and facilitates face to face social and business connections.

## 3.2 Role of Public Transport

For urban transformation to be achieved and then maintained requires an appropriate public transport system. By appropriate is meant that it is in-synch with cycling and walking and discouraging of private car use (particularly that which is low vehicle occupancy at periods of peak demand).

In regard to achieving urban transformation (as distinct from maintaining it once achieved) there is a quite fundamental issue relating to selection of an appropriate public transport system. This concerns the catalytic effect of public transport on urban transformation. As with any catalyst it lowers the threshold (reduces the resistance) for change to occur. The change in this case is that of urban transformation. This is very much about people willingly investing, living, working, socialising and so on in the particular urban precinct. Their willingness derives from the confidence they have that the public transport system provided meets the required performance criteria (as above) and especially that it will be provided on an ongoing basis. That is, it is permanent and not liable to be removed or down-graded.

It is a long-standing and often used assertion that only rail can provide such permanence and so confidence[7]. This being a consequence of the permanence of rail track (and so of route location) – once in place it cannot readily be removed or relocated. This contrasts with

[7] There is significant evidence that such confidence manifests as increased land value particularly surrounding rail stations [Newman, P; Jones, E; Green, J; & Davies-Slate, S; *"Entrepreneurial Rail Model: A Discussion Paper"*; Curtin University; February 2016].

bus services. Allied to the physical permanence of rail track is that rail passenger services are an inherently more substantial investment (particularly initial capital cost) than provision of a comparable bus service. Such an investment is one from which the proponent (invariably government and often through a contracted service provider) is most unlikely to retreat and so would readily be perceived as 'permanent'.

The **challenge and so opportunity** is to determine whether the same sense of permanence and consequent confidence as provided by rail can be achieved by a more cost-effective public transport system – without compromising the required performance criteria. This is considered in detail in Section 5 (sub-section 5.1).

## 3.3 Site Specific Public Transport Performance Criteria

Parramatta Road as a place for people, business and employment has two functions that of movement and place. Some elements are common to both and some specific to place and or movement. The approach for a strategic transport corridor such as Parramatta Road needs to combine both perspectives as well as a third practical element that of constructability.
Transport for London puts it simply - ***Think local, plan network***

Key considerations for the selection of an appropriate dedicated public transport system to enable the transformation of Parramatta Road are:

- Movement
  - Moving people from place to place efficiently
  - Providing a range and interconnection of different transport modes
  - Possibly higher passenger capacity per lane per hour in the right conditions (but with more standing)
  - Access for utilities and services, emergency response, deliveries
  - Safety avoiding collisions and providing a safe environment for movement in all modes
  - Adaptability and agility (avoids breakdowns)
  - Provides for north south as well as east west movement
  - Improved connectivity between places
  - Accommodates and encourages high level of pedestrian activity
  - Allows for short term parking and loading
  - Accommodating cycling
  - Access to bike and car share facilities
  - Reducing emissions
  - Reducing noise
  - Supports road intended function
  - Corridor preservation
  - Future proofing and preserving future opportunities
  - Mode and service integration
  - Amenity
  - Ride comfort
  - Aesthetics
  - Traffic management

- Customer preference and convenience
    - Business viability
    - Heritage considerations
    - Adjoining land use

- Place
    - Suited to current conditions and transitional aspirations
    - Social connectivity
    - Place identity
    - Limits impacts of construction
    - Reduces emissions
    - Reduces noise
    - Creates confidence through sense of permanence
    - Greener environment
    - Reduced heat island impacts
    - Increased housing supply
    - Increased jobs
    - Increased business activity and viability
    - Accommodates and encourages high level of pedestrian activity
    - Allows for short term parking and loading
    - Safety avoiding collisions and providing a safe environment for movement in all modes
    - Supports and builds sense of community and place identity
    - High amenity of the public realm
    - Demonstrated level of public investment in quality community infrastructure
    - Aesthetics
    - Traffic management
    - Suited to customer preference and convenience
    - Heritage conservation
    - Adjoining land use

- Constructability
    - Suited to the physical environment
    - Meets and identified need
    - Fit – road width and gradient
    - Network integration
    - Safety
    - Cost of implementation – route construction and vehicles
    - Services and relocation
    - Timeliness – lead time to operation - open day one of WestConnex
    - Resilience
    - Flexibility and futureproof,
    - Progressive implementation
    - Suited to staged construction
    - Construction impacts and duration
    - Politically acceptable
    - Broadly supported by community and stakeholders

The diagram below was developed by Transport for London as part of a Toolkit to assist Local Councils to classify a road according to its purpose. The purpose of a road being two-fold: facilitating 'Movement' of traffic and providing a 'Place' for activities. The various classifications represent the differing extent to which one or the other ('Movement' or 'Place') is to be served by the road purpose. An understanding of the two-fold purpose of a road is especially important when the two functions compete, such as Parramatta Road where there are increased 'Movement' requirements versus the need for improved 'Place' amenity. The arrows placed within the matrix show the tension between the stated intent of the PRUTS that Parramatta Road remains an arterial road and the vision for it to become again a vibrant corridor of enterprise with greater place importance at precinct hubs.

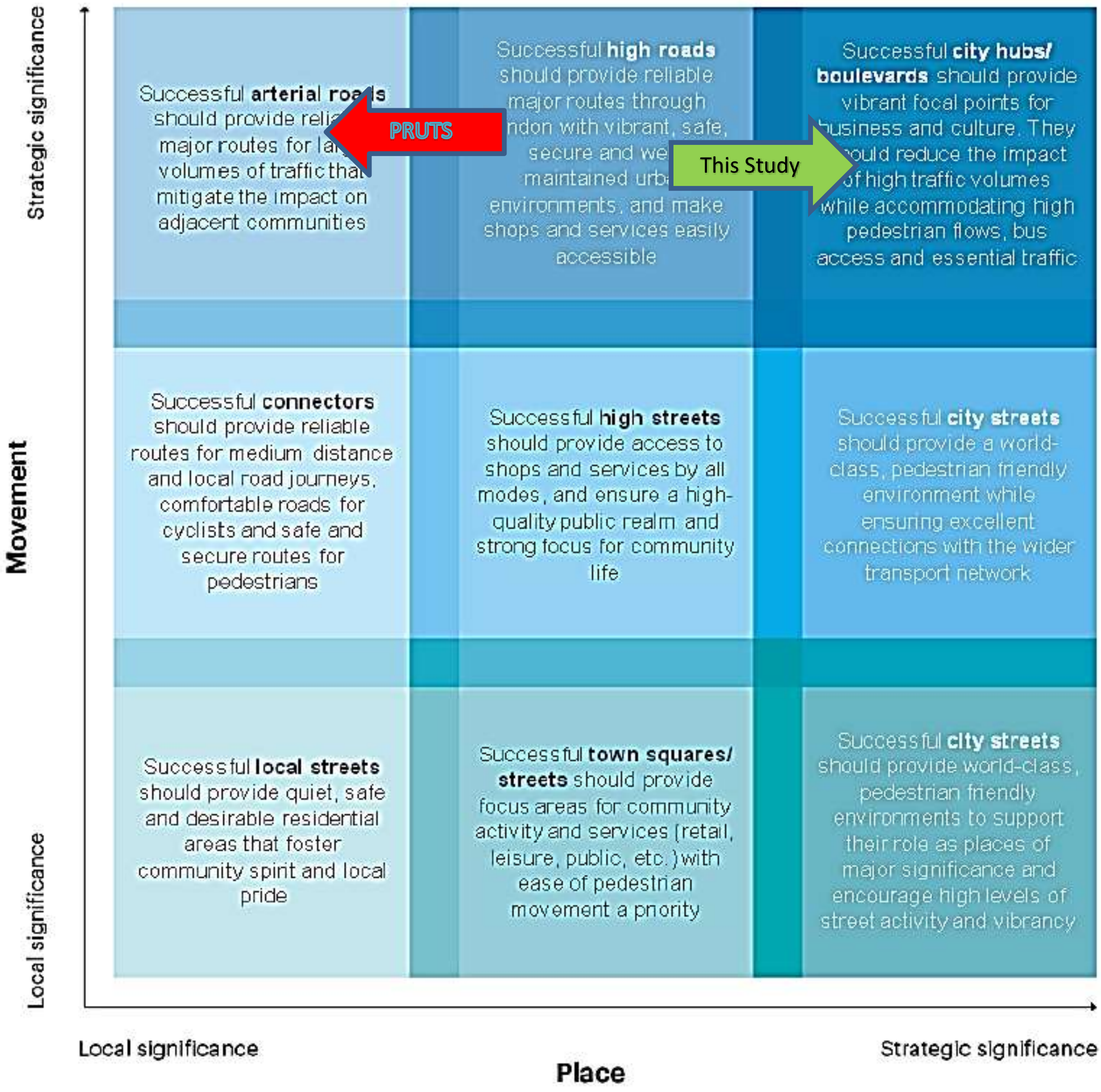



*Figure 7 London's Street Family Matrix*

This approach recognises that the road network consists of a mixture of different road types serving different functions within the total transport network. It also accommodates the idea that along a corridor that the road may consist of different types being both an arterial road and a city hub.

- Movement roads are used to travel between places.
- Place roads are in themselves origins and destination of travel that people move between

***Parramatta Road will remain a State Arterial Road***. It will continue to perform a Movement function for the majority of its length, and ***will retain a minimum of one public transport lane and two general traffic lanes for each direction of flow along its full length***[8].

The final Parramatta Road Transformation subtly but significantly minimises the 'Place' function of Parramatta Road itself and no longer envisages Parramatta Road as- ***"a living street: a corridor of enterprise"*** but more simply as a high quality multi-use corridor - ***as a State Arterial Road***.

It is the tension between the vision and intent, 'Place' and 'Movement' that needs to be addressed through the opportunity to provide high quality public transport that will support transformation as originally envisaged, returning Parramatta Road to the vibrant high road it once was.

Previous Studies have varied in road configuration from considering a reduction in part to one lane of traffic each way with dedicated transport lanes and verge parking to two lanes of peak period dedicated public transport and two general traffic lanes along its entire length. It is the later that is the stated preference of the PRUTS.

Based on the framework above Parramatta Road is currently an arterial road and it is intended in the PRUTS that it will continue to service this role. There is an upper limit to which high speed private traffic can be accommodated and still meet the stated urban transformation objectives. The original PRUTS vision is more closely aligned to Councils aspirations where Parramatta Road functions as a high road, supporting local businesses and where people are prioritized over vehicles. Clearly there is a conflict of intent and this must be reconciled in a practical way.

'Additional road capacity tends to generate additional traffic volumes. Other initiatives are required for growing transport movements'. *City of Sydney Review of the WestConnex Business Case SGS Economics.*

[8] Parramatta Road Urban Transformation Strategy 2016

# 4. PARRAMATTA ROAD


**Now**

*The Parramatta Road corridor is characterised by chronic traffic congestion, loud noise and low quality commercial premises. The corridor, which connects Sydney CBD to Sydney's second CBD, Parramatta, is a priority area for the long term growth and improvement of Sydney*[9].


*Figure 8 Parramatta Road congestion*

**Future**

*The vision being for Parramatta Road to be a high quality multi-use corridor, with high amenity and balanced growth of housing and jobs "a living street: a corridor of enterprise"*10.

*Figure 9 Van Hool Electric vehicle concept*[11] *(source Quebec Study)*

[9] http://www.urbangrowth.nsw.gov.au/projects/parramatta-road/#sthash.HmVoo45u.dpuf

[10] WestConnex Urban Renewal Framework Hassell 2013

## 4.1 Pertinent Characteristics

The information provided in the following section has been primarily drawn from Transport for NSW publicly available data together with the supporting information commissioned for the Parramatta Road Urban Transformation Strategy and WestConnex. This provides sufficient insight to inform the conceptual level review of opportunities and constraints associated with the provision of dedicated public transit along Parramatta Road. It is acknowledged that further more detailed design studies will be required to identify the best configuration and test assumptions based on technical and engineering considerations, network operations and community and stakeholder needs.

### Road Gradients

The gradient over the 14.5 kilometre route from Strathfield to Central Station. Road gradient is not so steep as to inhibit vehicle selection.

- Start altitude is 10 metres end altitude 22metres.
- The maximum altitude is 40 metres and the minimum is 4 metres
- Maximum ascending gradient is 6% at 6.7 kilometres
- Minimum descending gradient is 7% at 5.4 kilometres

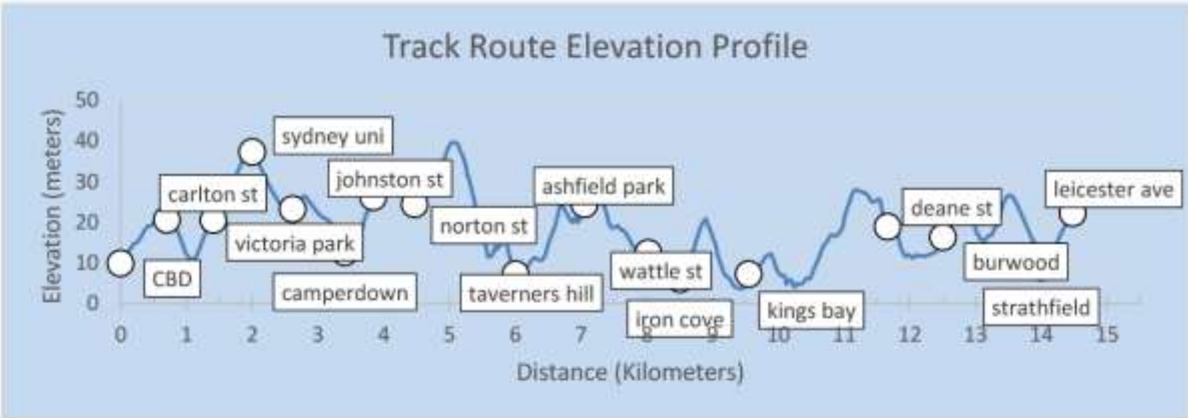



*Table 1 Parramatta Road Strathfield to Central Route Elevation*

### Road Width

The table below sourced from SIX maps provides approximate road widths both the width of the current road pavement kerb to kerb and the road reserve taken from lot to lot boundaries. Where there are 2 figures this indicates the variation of widths at this location.

| **Parramatta Road Approximate Road Widths** (source SixMaps) | | |
|---|---|---|
| **Intersection** | **Current Road pavement width metres** | **Lot to Lot (metres)** |
| Carlton Street | 24 | 34 |
| Victoria Park | 26 | 33 |
| Sydney Uni | 20 | 26-30 |

[11] Transports Quebec 2011 Étude de Faisabilité Tramway – Service Rapide Par Bus

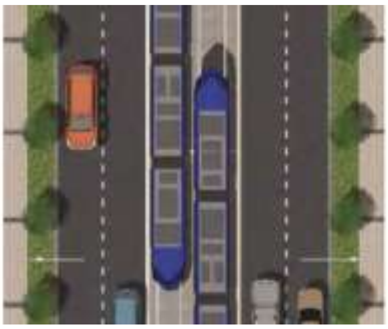
| | | |
|---|---|---|
| Larkin Street | 21 | 25-26 |
| Camperdown | 20 | 27 |
| Johnston Street | 20 | 27 |
| Norton Street | 17 | 26 |
| Taverners Hill (Tebutt) | 19 | 25 |
| Ashfield Park | 17 | 28 |
| Wattle Street | 22 | 30 |
| Iron Cove | 19 | 24 |
| Kings Bay | 17 | 23-26 |
| Burwood | 17 | 25 |
| Strathfield –Moseley Street | 10 | 25 |
| Leicester Ave - | 17 | 26 |

*Table 2 Parramatta Road Width*

Currently the minimum width accommodating the existing 6 lanes of traffic along Parramatta Road is 17 metres. Through these sections it is not possible to include station platforms and continue to provide two through lanes of traffic. Possible alternative treatments required to accommodate general traffic and stops at various locations are discussed below.

Typically the following configurations can be accommodated within wide medium and narrow corridor. Mostly with the exception of the inner city sections Parramatta Road is a medium width corridor and as such there are constraints in accommodating 4 lanes of general traffic and 2 lanes of public transport.

30+ metre reserve



22-30 metres less than 22metres

*Figure 10 Centre Running Configurations*

## 4.2 Travel Demand

The PRUTS reports that:

- 2.2 million trips are made within the Corridor daily
- 230,000 trips are made between 8am and 9am each week day
- 85% of all trips start and finish in the Corridor
- 30% of trips are greater than 10 kilometres
- 20% of trips are between 5 – 10 kilometres
- 50% of trips are less than 5 kilometres and of these 60% are less than 2 kilometres.

To achieve the transport objectives as outlined in the PRUTS it recommends that

- A shift to active and public transport be encouraged through the design of the precincts and frame areas.
- A shift in the dominance of parking be achieved through offering alternatives to driving and through parking controls
- Support BRT as WestConnex is delivered
- Take advantage of excess transport capacity by encouraging more diverse land uses especially additional housing and employment in the west of the Corridor
- Support network programs that support north south movements

The following information has been sourced from the 2011 Census at SA3 level, the Transport for NSW (TfNSW) Household BTS Travel Zones and from the draft PRUTS to gain an understanding of transport demand and existing travel behaviours within the Corridor[12].

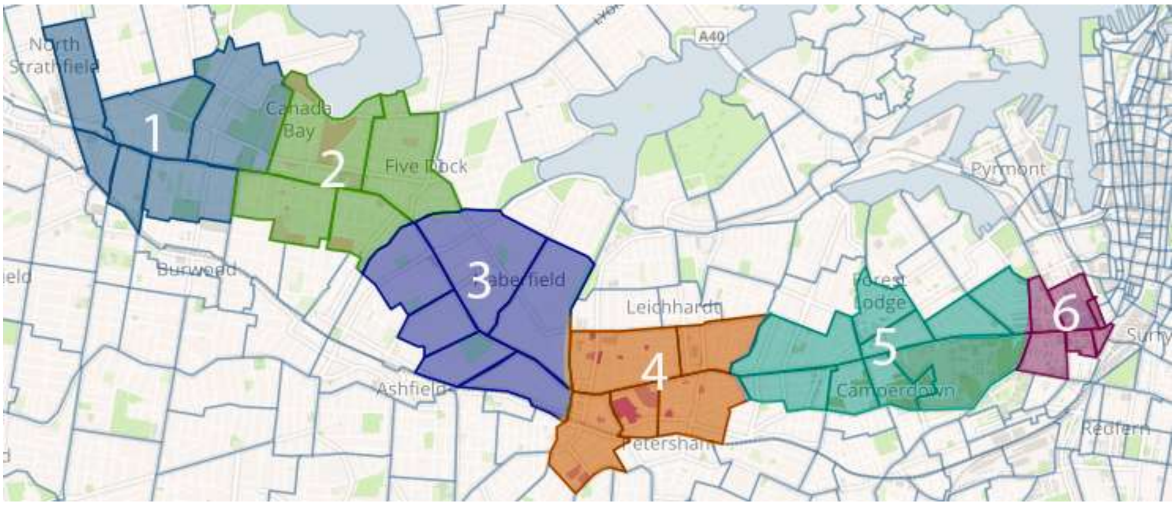



*Figure 8 Parramatta Road Corridor Travel Zones*

In 2011 sourced from TfNSW BTS Travel Zones showed that 37,980 lived and 4,471 worked in the area selected above. The pie charts below shows the mode of transport taken to work by those who live in the area and those who work in the selected area. Further detail on travel behaviours within precincts is provided at **Appendix A.**

[12] data source: 2011 Journey to Work Data Tables 12 and 13 based on the 2011 BTS Travel Zone (TZ) and 2011 Australian Standard Geographical Classification (ASGC) Standard Area 3 (SA3) boundaries

Residents living in corridor travel to work

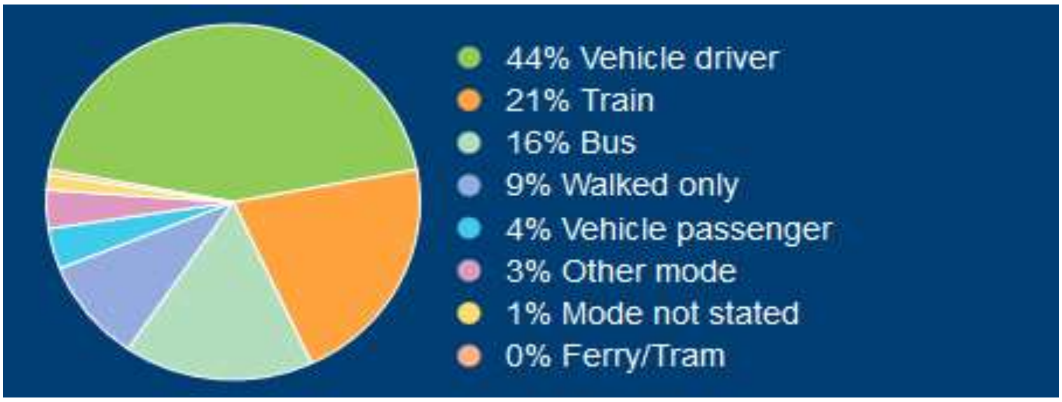



*Table 3 Corridor Residents Travel to Work (source TfNSW Household Travel Survey)*

Workers travelling to places of work in corridor

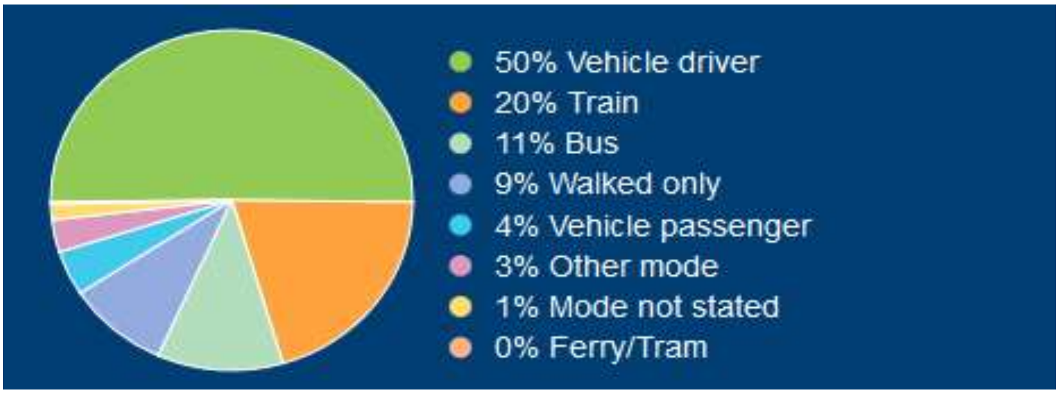



*Table 4 Workers Travel to Work within the Parramatta Corridor (source TfNSW)*

**Dwelling Structure**

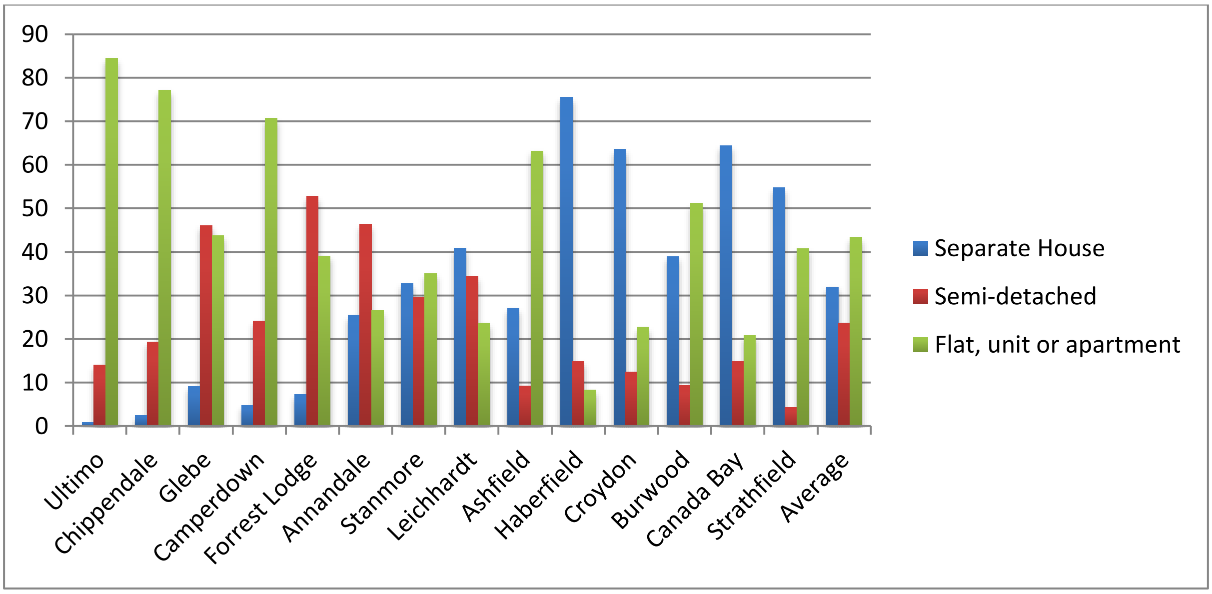



*Table 5 Dwelling Structure Parramatta Road Corridor ABS 2011Census*

### Vehicle Ownership

| **Motor Vehicles per Dwelling** (ABS Census 2011) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ultimo | Chippendale | Glebe | Camperdown | Forrest Lodge | Annandale | Stanmore | Leichhardt | Ashfield | Haberfield | Croydon | Burwood | Canada Bay | Strathfield | Average | Greater Sydney |
| 0.5 | 0.6 | 0.9 | 1 | 1 | 1.2 | 1.1 | 1.3 | 1.1 | 1.6 | 1.4 | 1.1 | 1.5 | 1.5 | 1.1 | 1.6 |

*Table 6 Vehicle Ownership Parramatta Road corridor ABS 2100 Census*

- The greatest percentage of bus users are those living or working closer to the Sydney CBD.
- Greatest percentage of walkers are those living closest to the CBD and centres of employment
- Greatest percentage of train users are those closest to the stations and with the longer journey
- Car usage correlates to access to transport services with those living in the Five Dock area are more likely to drive.
- Car ownership is greater the further from the CBD with the exception of Ashfield and Burwood car ownership is also influenced by dwelling type and Burwood and Ashfield have less separate houses.
- Housing type as the infill housing is likely to be predominantly units it is anticipated there will be higher demand for public transport and lower car ownership.

**Fundamental travel behaviour change is required to achieve the vision – not predict and provide for private vehicle traffic for evermore.** There is scope as part of the urban revitalisation program to guide this behaviour change through setting mode shift targets and implementing transport and parking initiatives to help achieve these targets.

Below are four of the relevant performance criteria suggested in the PRUTS Sustainabilty Implementation Plan released November 2016.

| Indicator | Sydney Metro | Existing | Base Case | Proposed |
|---|---|---|---|---|
| Estimated car use (VKT per person/day) | 20.0 | 15.1 | 10.7 | 7.5 |
| % reduction compared to Base Case | | | | ▼30% |
| Estimated car ownership rates (vehicles per household) | 1.5 | 1.4 | 1.0 | 0.8 |
| Car share take-up rate (%) | | | 0% | 13% |
| Car share potential (number of pods) | | | 0 | 131 |

*Table 5 PRUTP Sustainability Implementation Plan  Performance Indicators*

## 4.3 Impact of WestConnex

**The renewal impact on Parramatta Road is Questionable**

The importance of Parramatta Road is identified in the *Updated Strategic Business Case* in Section 2.6. Here, the current issues plaguing the corridor are correctly identified. However, the *Updated Strategic Business Case* appears to make a link between renewal of the corridor and the WestConnex project which is not supported through the data. The WestConnex M4 Widening Environmental Impact Statement (EIS) showed that under WestConnex, Parramatta Road will take more traffic in the future, not less (M4 Widening EIS, Appendix D, p. 144).

The EIS also found that tolls on the newly widened M4 would result in a 35 per cent increase in the number of weekday vehicles on Parramatta Road. The introduction of tolls on the M4 will see a higher number of vehicles use Parramatta Road as an alternative to the M4 due to toll avoidance. When tolls were removed on the M4 in 2010, traffic on Parramatta Road fell by 24 per cent in the morning peak. If tolls are reinstated on the M4, it is reasonable to assume traffic will avoid the tolled M4 and use the free Parramatta Road. ***City of Sydney WestConnex Business Case Review February 2016***

The following predicted changes in traffic volumes along Parramatta Road have been sourced from the WestConnex Updated Strategic Business Case Technical Paper 1 Traffic Report 2016.

- The blue bars represent the 2012 base case
- The orange bars represent the traffic volumes in 2031 for the 'do minimum' case
- The green bars represent the traffic volumes in 2031 with WestConnex.

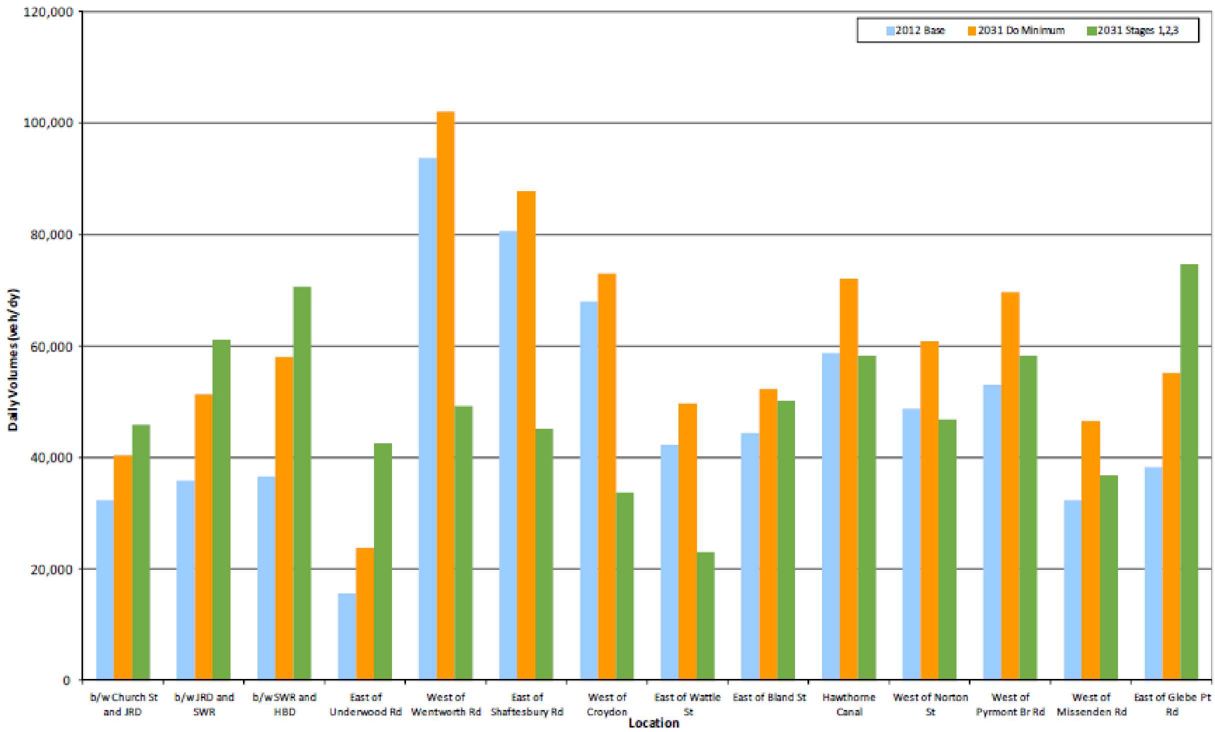



*Table 6 Current and Predicted Traffic Volumes on Parramatta Road*

The graph above of average weekday traffic volumes shows traffic will:

- Reduce by around 25,000 to 50,000 vehicles per average weekday between Wentworth Road to Wattle Street.

- With WestConnex, the volumes along Parramatta Road are predicted to increase by around 5,000 to 20,000 vehicles per average weekday between Church Street and Underwood Road when compared with the 'do minimum' situation.
- Weekday volumes along the eastern section of Parramatta Road will reduce by up to 13,000 vehicles per average weekday, except for the section east of Glebe Point Road, which is predicted to experience higher volumes up to an extra 20,000 vehicles per average weekday. Further investigation is on-going to assess how this impact could be mitigated[13].

These results are based upon the existing lane configuration along Parramatta Road that varies between six and four lanes wide. The 2031 scenario with WestConnex assumes Parramatta Road between Concord Road and Camperdown is reduced to four general traffic lanes throughout (as a result of planned public transport improvements in the corridor).

**Truck Volumes on Parramatta Road**

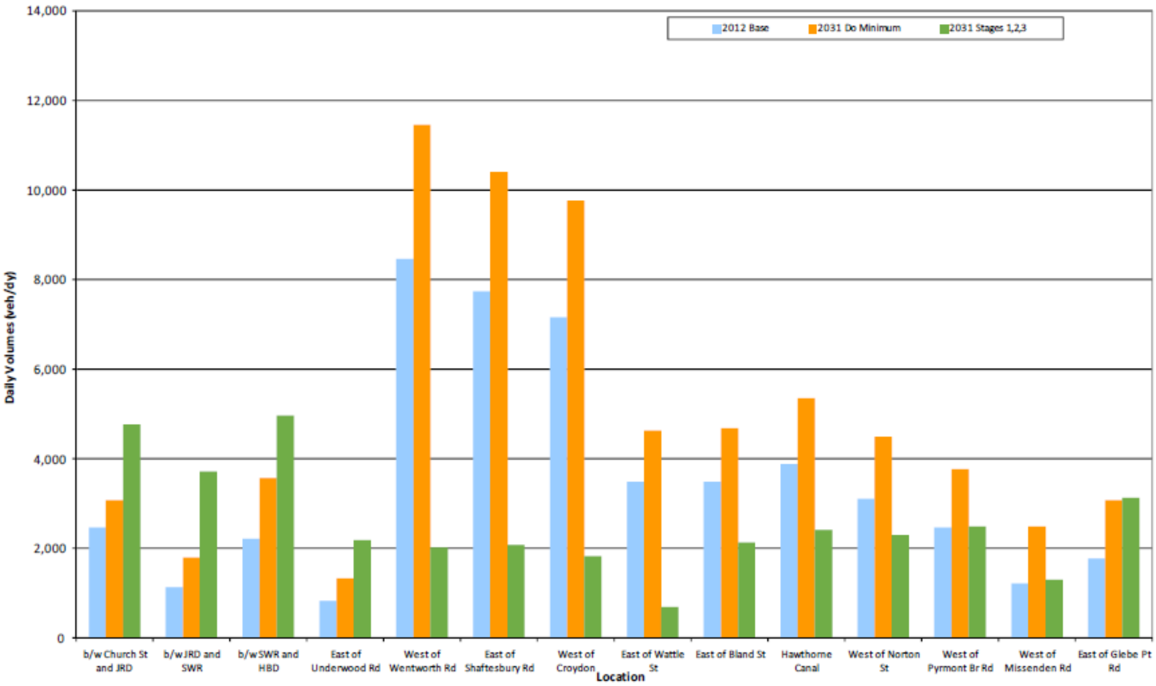



*Table 7 Current and Predicted Truck volumes on Parramatta Road*

- The blue bars represent the 2012 base case
- The orange bars represent the traffic volumes in 2031 for the 'do minimum' case
- Green bars with all stages of WestConnex completed 2031

The graph above shows average weekday heavy vehicle volumes along Parramatta Road for a range of future scenarios:

- The truck volumes along Parramatta Road west of Wentworth Road show increases when compared with 2031 'do minimum' scenario

[13] The removal of the Camperdown interchange changes this see Appendix C for more detail.

- Heavy vehicle volumes east of Wentworth Road will reduce by around 10,000 vehicles per average weekday, except for the section of road east of Glebe Point Road
- The section east of Glebe Point Road will continue to experience the same number of trucks per day as compared with the no WestConnex case
- Truck volumes along Parramatta Road west of Wentworth Road are forecast to increase on average by about 1,500 vehicles per day
- Truck volumes on the eastern end of Parramatta Road at Missenden Road will reduce by approximately 1,000 vehicles per average weekday. This equates to removing on average around 4,000 trucks per average weekday over this section of Parramatta Road.

**Implications for Parramatta Road**

WestConnex demand modelling predicts that with and without WestConnex traffic volumes will increase on Parramatta Road from Church Street to Underwood Road and from Pyrmont Bridge Road to Glebe Point Road. It is predicted that WestConnex will reduce traffic significantly between Wentworth Road and Norton Street. In some sections WestConnex will reduce traffic yet in other areas it will add to congestion. To address this situation and enable the revitalisation of Parramatta Road as envisaged **dedicated public transport infrastructure is required now.** It will plays a dual role of claiming the freed space from unleashed latent demand but also is part of the solution to address the increased traffic by incentivising a mode shift from private cars to public transport and providing choice and capacity in the public transport system. An affordable and innovative network of electric vehicles can bring about the required change, will claim the space, support the desired development outcomes.

Public transport along Parramatta Road will not have as its primary function moving masses of commuters into the CBD it will be a high frequency 'localised' (up and down Parramatta Road) – that will facilitate travel between precincts and employment nodes it will assist the reactivation of 'high-street'.

***This integrated approach to public transport will mitigate against the latent demand for private car use that will be unleashed by WestConnex.[14]***

[14] Should this opportunity not be taken from Day One of the opening of WestConnex Stage 3 Part 1 (the M4-M5 Link Tunnel between Haberfield and St Peters – if approved), Sydney will simply have 2 major arterial routes rather than a motorway underground and a surface route designed to cater for local access with

## 4.4 Stakeholder Input

The opportunities and constraints for the corridor were developed in consultation with key stakeholders and over a series of workshops with Councils staff. These were developed by Precinct with additional influencing or overarching factors identified separately.

<u>Context for Parramatta Road Transformation</u>

To enable people and vehicles to move more efficiently along Parramatta Road there are two key changes required:

- To transform the environment for cycling, walking and public transport
- To improve the public realm and provide better and safer places for all the activities that take place on the city main street, and provide an enhanced quality of life

### Summary of themes

- Move Parramatta Road from being a place for cars to a place for people
- "Now is the time"
- Needs to be a region-wide funding approach
- The important thing is to preserve the corridor
- "Getting people into these places without their cars"
- Classification of stops is important
- Loops, included in plan, even if long term staging will help with community support
- Parking availability - short term vs long term parking
- "If we get a link between Burwood and Strathfield we are talking about a network"
- Strathfield Station as an intermodal node provides linkage - CBD and broader region
- A network is required and this needs to include the option for linking of Olympic Park, Wentworth Point, Rhodes and Concord Hospital.

reactivated street frontages, a friendly pedestrian/shopper environment with lower car traffic speeds and reliable, modern, efficient public transport.

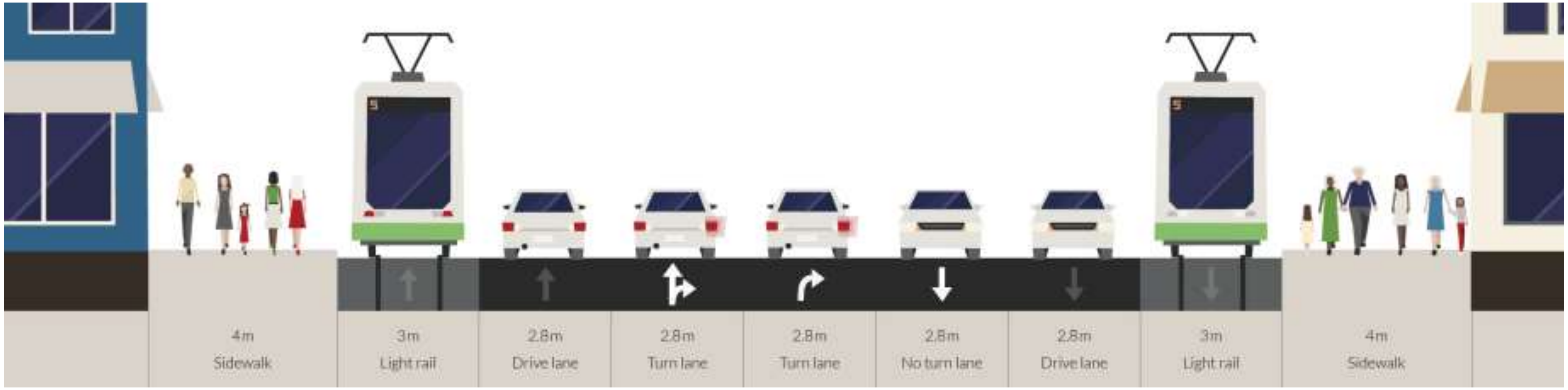
## 4.5 Site Specific Investigations

The following section explores the implications of kerb and centre running public transport at key points along Parramatta Road. It provides a photograph of the road as it is now and cross sections for both kerb and centre running vehicles. This work is indicative only, based on high level preliminary investigations it has been developed to inform this Study. There is a clear understanding that prior to decisions being made detailed design and feasibility studies will be undertaken.

## Intersection of City Road and Broadway


*Figure 9 Intersection of City Road and Broadway*

Broadway travelling east at the intersection of Broadway and City Road 28 metres

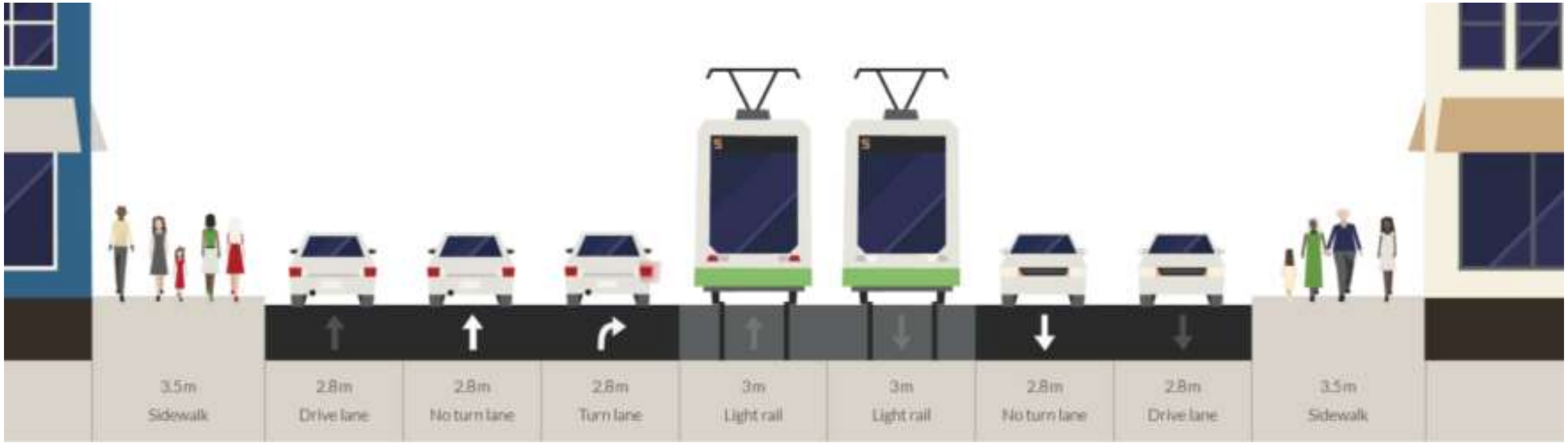


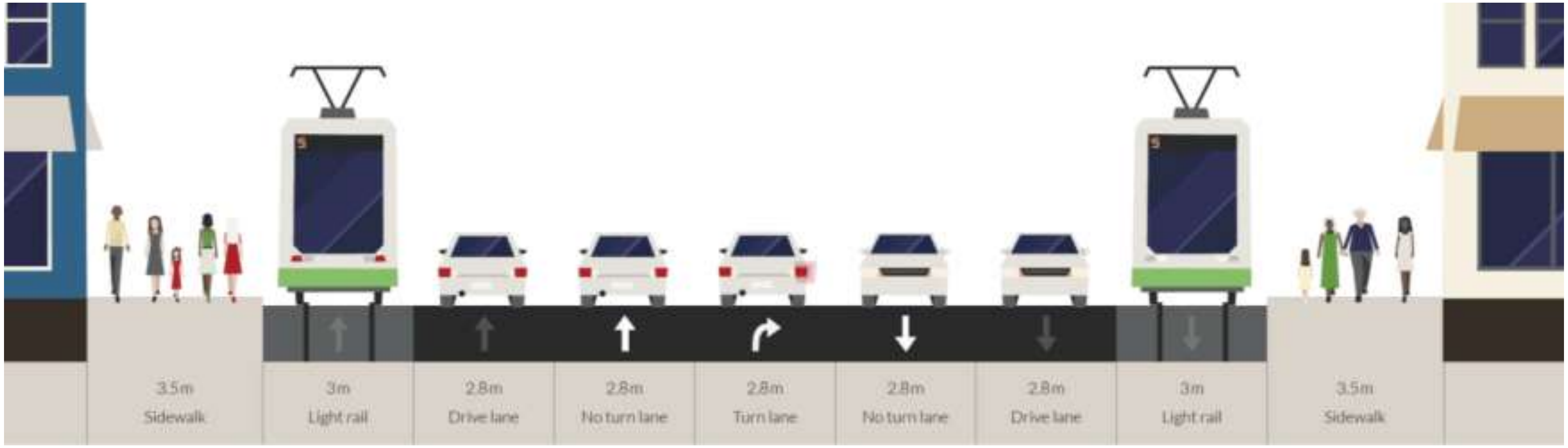

As can be seen from the images above key intersections such as Broadway and City Road  require follow-on detailed investigation.

## Camperdown Precinct intersection of Missenden and Parramatta Road


*Figure 10 Camperdown Precinct - intersection of Missenden and Parramatta Road*

Camperdown Precinct - intersection of Missenden and Parramatta Road 27 metres



**Camperdown Precinct Intersection of Parramatta Road and Pyrmont Bridge Road**

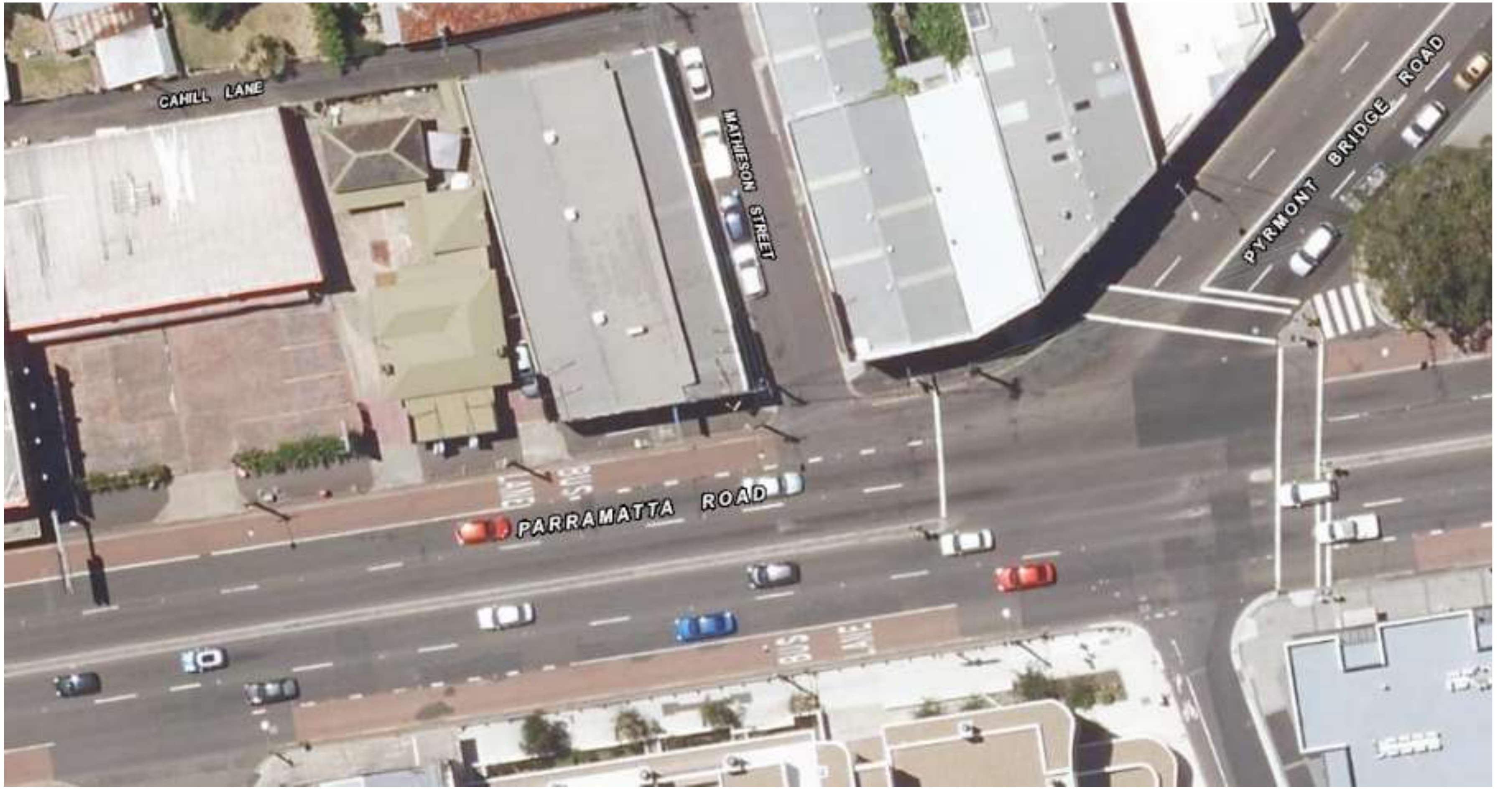



*Figure 11 Camperdown Precinct - Intersection of Parramatta Road and Pyrmont Bridge Road*

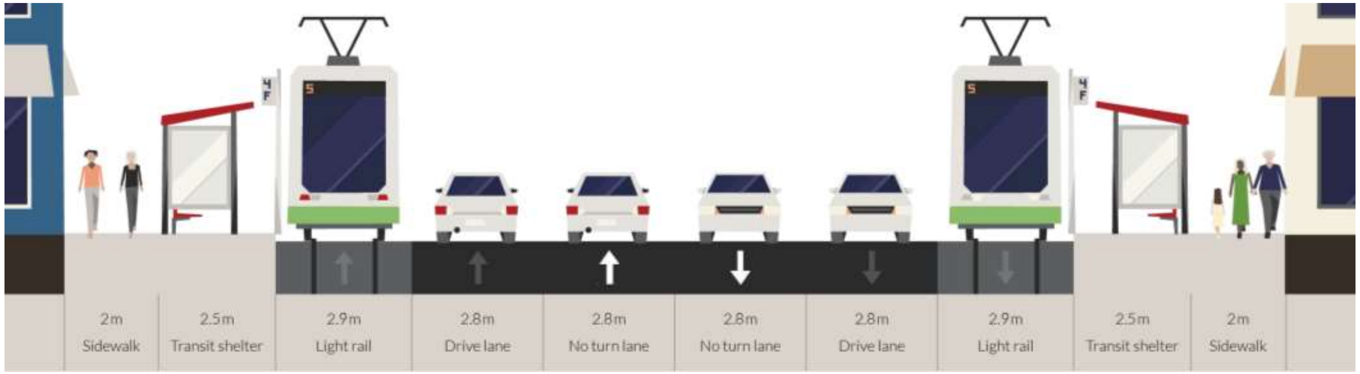
**Camperdown Precinct Intersection of Parramatta Road and Pyrmont Bridge Road 27 metres**


A pavement width of 4 metres is shown to accommodate station stops. Other options could include the provision of embayed parking at key places within landscaped verge and station infrastructure where required. The reuse of existing heritage buildings as meeting places and transport support services (bike and car share facilities, opal card top up and purchase, tourist information and on demand transport connections). Could provide comfortable an all weather protected environment and meeting space. Centre running below shows station stop in median with bike facilities off peak parking at verge to service businesses and provide traffic separation for pedestrians and on-pavement dining.

**Leichhardt Precinct Norton Street and Parramatta Road**


*Figure 12 Leichhardt Precinct Norton Street and Parramatta Road*

**Leichhardt Precinct Norton Street and Parramatta Road 26 metres**




In Leichhardt the heritage buildings are an underutilised asset and there are opportunities for activation around station stops. Ideally suited in the short term for business incubator and creative industries as well as range of bike share and transport related services. Road space is limited and kerbside parking may be difficult to achieve in this section. An electric vehicle will provide an emission free, slow moving safe traffic environment for pedestrians and shoppers. Norton Street and Balmain/Crystal are important north-south connectors. To accommodate a station stop for centre running could possibly be achieved through inclusion of a roundabout at Crystal Street and Balmain Road, facilitating north south movement and providing sufficient space for a station stop between Norton and Balmain. On basis of the predicted reduction of traffic on Parramatta Road (consequent of WestConnex) there is opportunity to combine the Norton Street and Crystal Street intersections as one. This would provide space to include a station stop and free pedestrian movements and facilitate north-south connectivity

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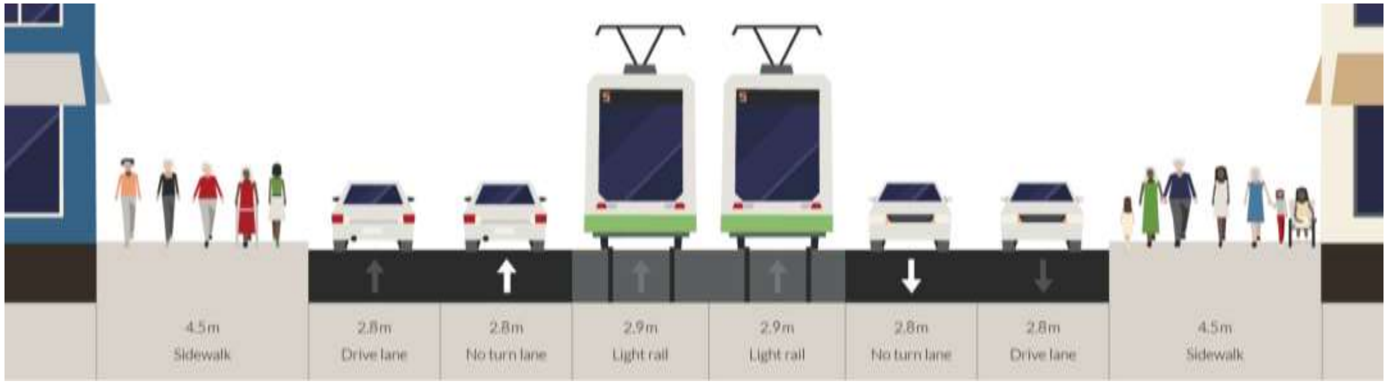


**Taverners Hill (Super Stop inclusive of Inner West Light rail stop)**

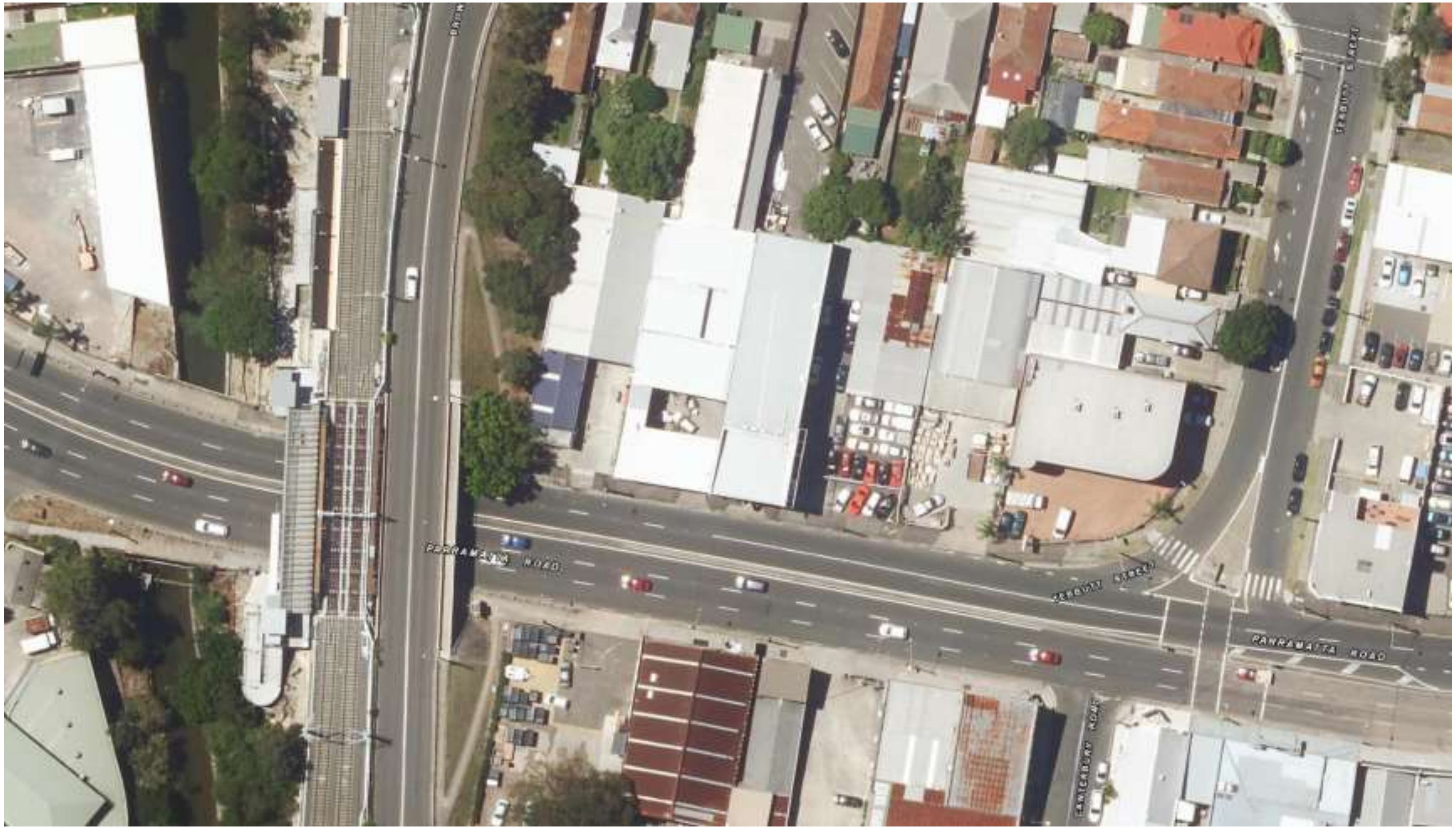
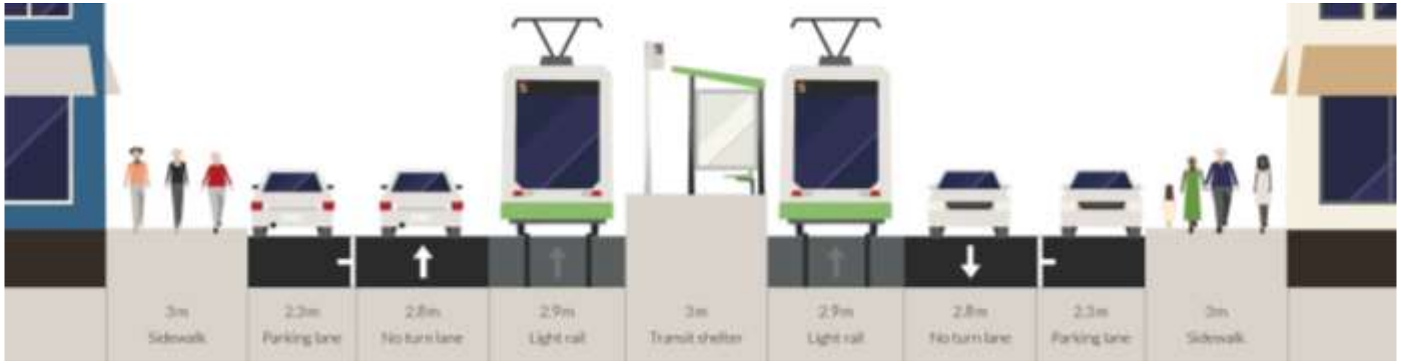
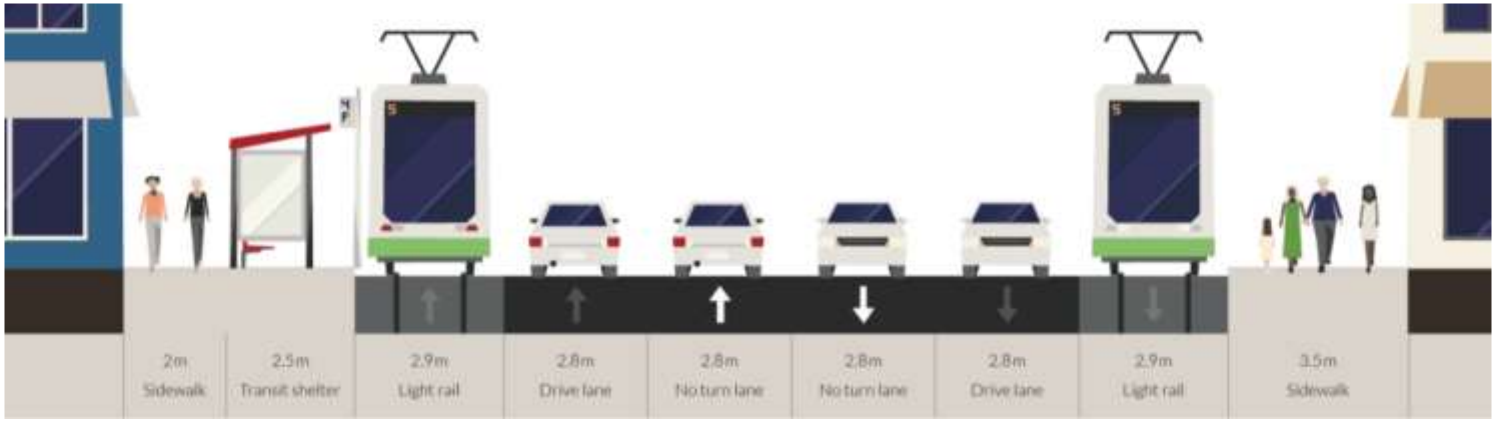


*Figure 13 Taverners Hill Super Stop*

**Taverners Hill - near Tebbutt Parramatta Road intersection 25 metres**




There is opportunity with the proposed redevelopment of the Taverners Hill precinct to gain additional land that would enable centre running. Currently without redevelopment or land resumption a staggered stop kerbside or roundabout Old Canterbury to Tebbutt would enable centre running. There is sufficient road width at 18metres kerb to kerb under the bridge to accommodate the 2 dedicated transit lanes and two general traffic lanes. It is noted that at this point traffic heading east is reduced from 3 lanes to two lanes and there is a concrete barrier separating traffic. Consideration needs to be given to the safest solution for this section that could be centre running in a protected corridor due to the slower speed and predictability of the vehicles due to the guidance system.



## Iron Cove Great North Road and Parramatta Road

*Figure 14 Iron Cove Great North Road and Parramatta Road*

**Iron Cove Great North Road and Parramatta Road 30 metre width**

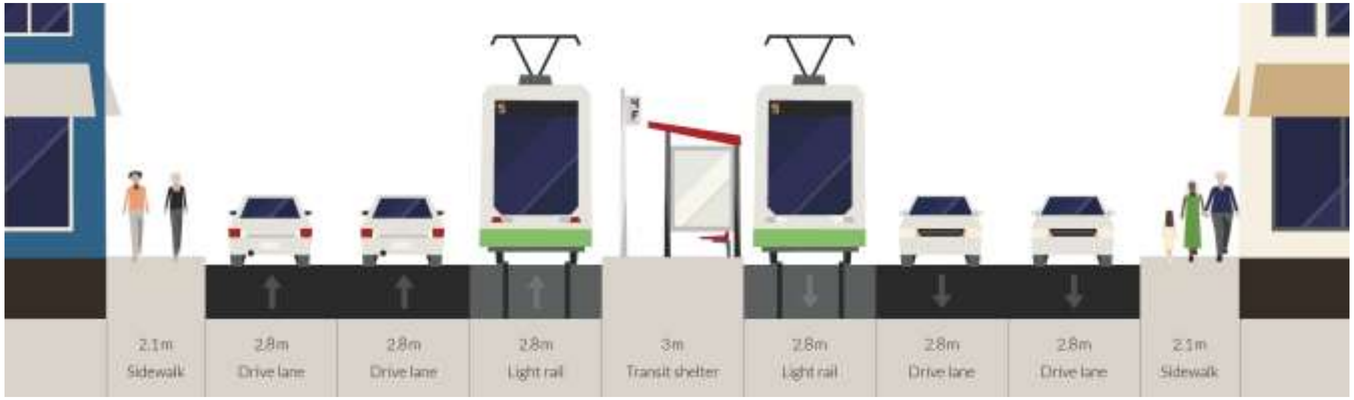

Great North Road and the nearby Iron Cove Creek reserve offers great opportunities for mode interconnection including a fleet of small frequent feeder electric vehicles moving quietly connecting the suburbs of Five Dock, Iron Cove, Canada Bay and Concord, Abbotsford, Chiswick, Drummoyne etc. Providing distinctive and high quality public transport will assisting mode shift and in the development of the area including the Five Dock Town Centre. It will assist to build community and social connections as people travel together in small numbers to employment destinations and sporting facilities. The Iron Cove Creek green spine provides opportunities for mode share between walking, cycling and bike share. The intersection of Great North Road and Parramatta Road could be suited to a roundabout inclusive of super stop (Precinct stations as identified in the PRUTS) entry statement. It is noted that the former tramway had a spur that went down Great North Road (refer Appendix D: Historic Tram Network)

Roundabout integrating cycle and station infrastructure Delft Holland

## Kings Bay Precinct Parramatta Road west of William Street


*Figure 15 Kings Bay Precinct Parramatta Road west of William Street*

**Kings Bay Precinct Parramatta Road west of William Street 24 metre width**




Centre running along Parramatta Road from Taverners Hill to Strathfield provides opportunity for a landscaped median as a safe pedestrian refuge. It also accommodates on-street short term parking to service local businesses, calm traffic and buffer impacts on pedestrians supporting the development of finer grained uses. Where possible as properties redevelop embayed parking and landscaping could further improve local amenity and greening of the corridor. However currently without development the pavement would be narrow with centre running

Kerb running provides greater opportunities for median planting but limits the longer term opportunities for public realm improvements. Through areas where there is little requirement for frequent stopping vehicles may travel more quickly and this would not be as suitable for kerb running.

**Intersection Parramatta Road and Burwood Road**


*Figure 16 Intersection Parramatta Road and Burwood Road*

A stop in close proximity to Concord Oval and Parramatta Road would service the sports ovals. Investigation has also considered including one way loop down Shaftsbury Road and up Burwood or two way in and out on Burwood to provide interchange opportunity with the heavy rail, service the local area and take passengers into the Burwood town centre.

## Parramatta Road Moseley and Leicester loop


*Figure 17 Parramatta Road Moseley and Leicester one way loop*

Consideration of a loop to Strathfield station utilising potentially Mosely and Leicester streets. There have been investigations of how the Parramatta light rail will access Strathfield and integrating these systems would provide additional interchange opportunities

## 4.6 Proposed Configuration

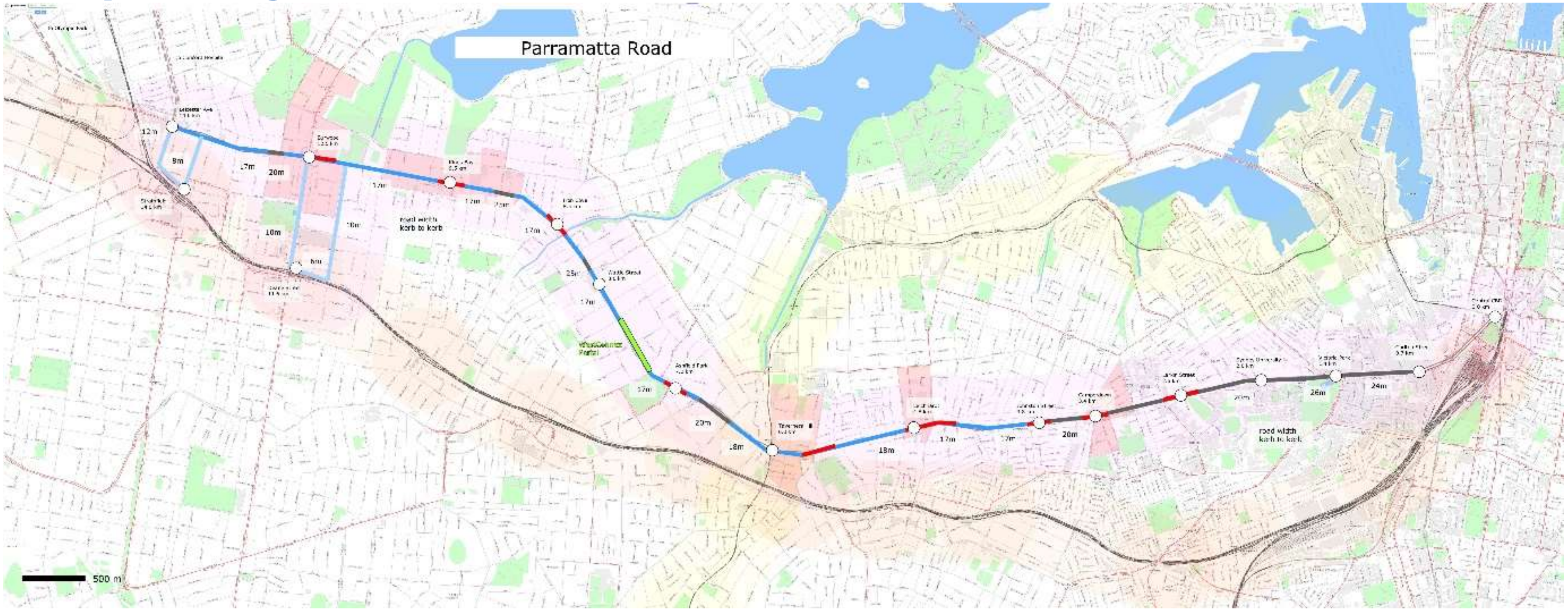



*Figure 18 Map of Proposed Configuration*

The map shows the super-stops as identified in the Draft Parramatta Road Transformation Strategy. Additional stops have been added at key points to assess the viability of the corridor to accommodate two dedicated transit lanes inclusive of stations and the retention of two general traffic lanes. The spacing and exact location of stops will require further investigation with consideration given to catchment, mode integration and design constraints to accommodate station infrastructure and road safety. Although not discussed in detail in this document consideration is also given to taking the dedicated transport infrastructure to Homebush. This option provides advantages in servicing a high demand growth area, linking with the Parramatta light rail and heavy rail, and providing additional transport choices at times of peak demand during events.

## Route and Station Location

Termination points

- Burwood
- Strathfield
- Rhodes
- Homebush
- University of Sydney
- Central Station

## Kerbside or Centre Running

As discussed above in the site specific investigations there are advantages and disadvantages for both centre and kerbside running and the answer for Parramatta Road is not clear cut. The function of Parramatta Road varies along its length and there are areas where there are physical constraints and heritage considerations and the type and nature of trade and the level of activity and order of land use varies.

It is considered that Centre running is the most appropriate configuration for the following reasons:

- Provides opportunities for kerbside parking to support businesses
- Parked vehicles buffer pedestrians from traffic
- Best claims and protects the public transit dedicated corridor
- Sends the strongest message of commitment and change
- Better supports urban regeneration and value uplift
- Provides better access for turning vehicles
- Dedicated lanes can be utilised by light rail if later preferred
- Provides greater traffic demand management options

***Capacity***

The capacity of a transit system is to be considered in three dimensions*:*

- Network capacity - accounting for whole journeys made by passengers, the potential for a transit network to provide trips across a number of different routes
- Peak line capacity - the number of passengers passing through a single point on the network at peak hour
- Terminal capacity - the capacity of facilities allowing passengers to alight from transit services

In essence the key difference between full service BRT and LRT is that BRT offers a high level of system capacity to cater for travel demand over a variety of different paths, whereas LRT provides arguably superior performance for travel demand consolidated to a corridor.

Parramatta Road needs to continue to provide a network function. The Inner West is not featureless sprawling suburbia but a region of high natural amenity with areas of significant heritage and cultural value. These assets can and are being realized providing additional opportunities for commerce and employment, higher density housing, vital town centres and inner city living. These areas and many of the key employment centres are some distance from the Parramatta Road and a transport network (spine and spur) rather than a corridor is required.

Line capacity can be accommodated through more frequent services. The peak line capacity of BRT can surpass that of light rail, where there are double-lanes at stations so that vehicles can pass one another. Specific design considerations of platform size, vehicle capacity, and pre-boarding fare collection infrastructure are key to determine the potential number of passengers that can board or alight from vehicles at peak times.

*Terminal capacity can be a significant issue for transit systems feeding to high-density city centres.*

This is true of Parramatta Road and consideration will need to be given to the need to access the Sydney CBD and how this is best accommodated to preserve service reliability. Terminal capacity is a key constraint, and while it depends on the specific design of terminal stations, vehicle size is an important determinant.

Both stop and terminal capacity may limit the maximum length of vehicles. The maximum capacity 78 metre LRT vehicle being suggested for the CSELR may have amenity and traffic impacts in heritage precincts where block length are shorter the scale is arguably not suited to a finer grained urban environment.

## 4.7 Connectivity and Network Resilience

**Spine and Spur**

In light of travel patterns and demand as well as the announced new transport links including the Parramatta to Strathfield light rail and the new West Metro line, consideration has been given to a spur line that would connect Concord Hospital to Rhodes, Wentworth Point and Olympic Park.

It is intended that the Parramatta Road transit route discussed in this report would continue along Parramatta Road to connect with the Parramatta to Strathfield light rail[15] providing a spine along the corridor that extends from the Parramatta CBD to the Sydney CBD. It is important that the spine provides through its infrastructure (more substantial stations and recharge points) the sense of permanence that is associated with the catalytic affect required to support transformation. The spurs are network supporting infrastructure and provide flexibility to accommodate local demand, support social connectivity and provide overall system resilience. The spine and spur system complements the greater capacity, high speed metro lines both existing and proposed.

There was previously and extensive tram network that provided good coverage to the north and south of Parramatta Road and linked to the heavy rail. With the tram network closure in 1961 buses have taken over this role and increasingly private car usage became the norm. Although there are bus routes through the area it is apparent from the travel behaviours

[15] It is noted that the Parramatta to Strathfield light rail is still in the planning phase and its implementation date has been delayed. This Study considers the opportunity for extension of the system to Parramatta prior to commitment of the light rail

(section 4.2 and Appendix A) and the access map below[16], that particularly in the Canada Bay area (section 2) that the existing provision of public transport is not achieving the patronage and mode share sought.  This has proved unsustainable and a suggested conceptual spine and spur model is presented below.

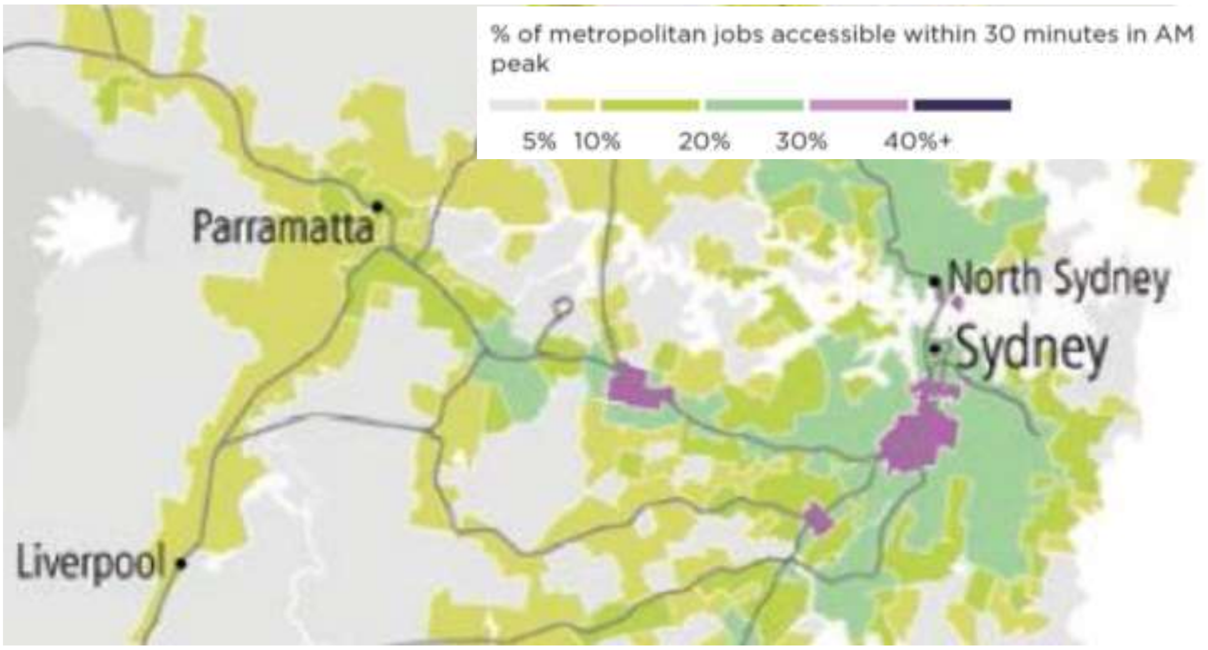



*Figure 19 Access to Jobs by Public Transport Exploring A Plan for Growing Sydney SGS Presentation Feb2015*

A possible future scenario presented in the TfNSW Roadmap 2016 suggests that emerging technological advancements in transport also will likely provide in the near future a range of more personalised options for first and last mile travel, including car and bike share and driverless autonomous pods.  These vehicles may ultimately provide on demand transport for point to point travel and could potentially be linked to the Opal card for seamless travel interconnectivity.

[16] Map taken from a presentation by Pat Fensham (SGS Economics) to the Planning Institute of Australia 2015. Map of percentage of jobs accessible within 30minutes by public transport highlights the transport issues for people residing between Parramatta Road and the Parramatta River with the pale pink areas indicating the limited access (less than 5%).

**Concord - Rhodes Spur Concept**


Lyons Road Canada Bay

The areas between Parramatta Road and the Parramatta River offer very high natural amenity provide opportunities for infill development. The map below shows the reinstatement of some of the former tram routes (Appendix D) and linkages to key employment destinations. The route would possibly include from Parramatta to Road Great North Road, Lyons Road, Majors Bay Road, Nullawarra Avenue Concord Road Homebush Drive, Rider Boulevard, Gauthorpe Street and Hill Road onto Parramatta Road. This route would service in the short term the existing need being generated by the significant development currently occurring in the area and provides linkage to heavy rail and key centres of employment.

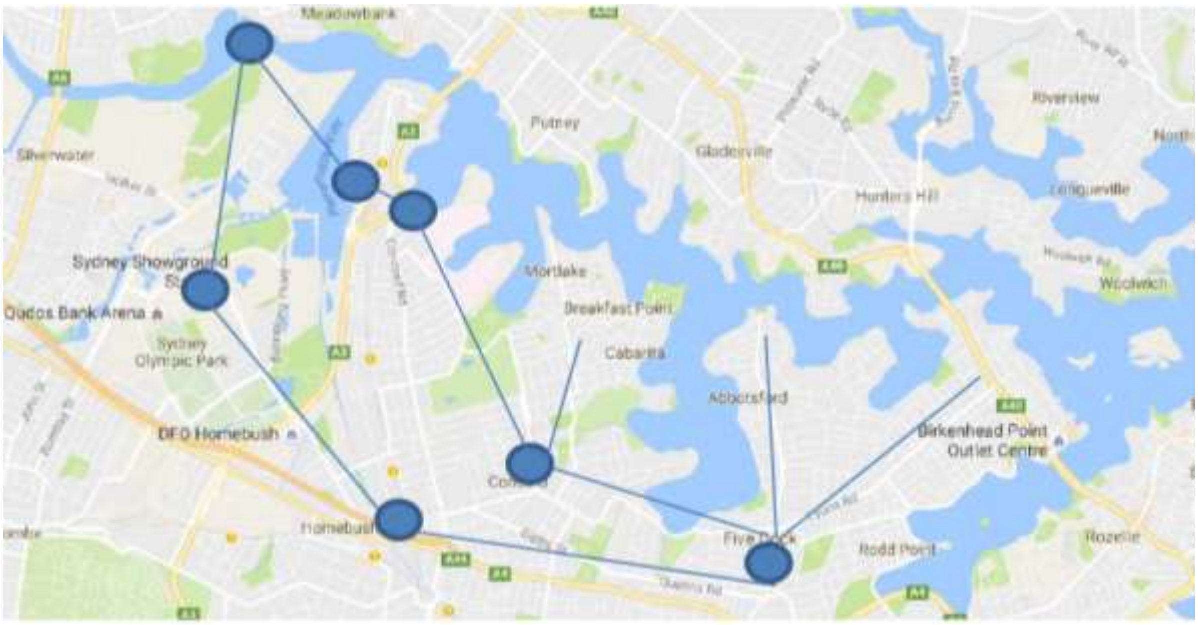



*Figure 19 Canada Bay Spur*

## Network Resilience and Flexibility

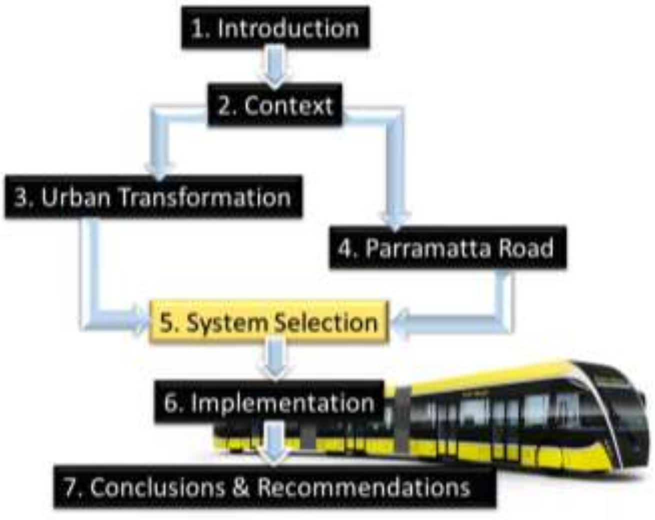
To future-proof investment decisions, it is useful to consider the transit network not as an isolated entity but in the context of its wider environment. The flexibility of transit services creates both advantages and disadvantages. Flexible routes allow the transport service provided to adapt to demand as a city grows, with potential for phased upgrades in service frequency and coverage.

An important consideration relevant to transport investment along Parramatta Road is increased occasional and long term demand resulting from events, mode shift and densification. In anticipating how capacity constraints may be managed in the long term a network approach whereby various types of public transport vehicles run concurrently, possibly within the same corridor, is a key element of network resilience.

**Upgrading to Light Rail**

Evaluation of the planning and evolution of the transit systems in international case studies show a tendency for cities with successful BRT systems to upgrade to LRT to increase the peak hour or terminal capacity. The 2015 study of transport options for Quebec took into consideration the upgrading of the electric tram bus system to light rail in the future and concluded that with the infrastructure in-place, the cost could be justified in the future if required rather than bear the expenditure at this point when the need was not proven.

# 5. SYSTEM SELECTION




## 5.1 Basis of System Selection

It was identified in Section 3 (sub-section 3.2) that the challenge and so opportunity is to determine whether the same sense of permanence and consequent confidence as provided by rail can be achieved by a more cost-effective public transport system – without compromising the required performance criteria.

Rail can take the form of heavy passenger rail which is best suited to moving high volumes of passengers quickly over long distances. It is not as well suited as light passenger rail to effecting urban transformation at a precinct level. It is then alternatives to light rail (as distinct from heavy rail) that are to be considered.

This has been incorporated into a relatively recent and relevant investigation [Mulley; C.; 12/12/2015]:

*"In terms of citizen acceptance, there is much evidence to show that there is a bias in favour of Light Rail. Politicians too seem to favour Light Rail (and these two facts may well be connected). But more recent research has shown that when the right questions are asked, bias is reduced when residents consider what they get from a system when budgets are fixed, especially the benefit of the wider network, connectivity and accessibility. Perhaps more importantly, when there is the experience of BRT, there is considerably more support and an absence of bias (or rather a bias towards BRT) – the 'Brisbane' effect (Hensher et al 2015a, Hensher et al 2015b)."*

In that investigation [ibid], a comparison of alternate public transport systems was undertaken. This is shown in summary form in the Table below (reproduced from the report of the investigation).

| | BRT | Urban Rail Transit | |
|---|---|---|---|
| | | **Light Rail** | **Metrorail** |
| **Rights-of-Way** | Mixed: shared (at-grade); dedicated and exclusive lanes | Exclusive (elevated or barriers) or shared (at-grade) | Exclusive, grade-separated |
| **Running Ways** | Pavement; roadways | Steel Track | Steel Track |
| **Vehicle Propulsion** | Internal Combustion Engine | Electric (overhead wires) | Electric (high-voltage third rail) |
| **Vehicle Control** | Operator/Visual | Automated/Sign Control | Automated/Sign Control |
| **Construction Time** | 1-2 Years | 2-3 Years | 4-10 Years |
| **Maximum Capacity** (passengers/vehicle unit) | 160-270 | 170-280 | 240-320 |
| **Maximum Capacity** (passengers/coupled unit) | 160-270 | 500-900 | 1000-2400 |
| **Minimum headway** (seconds) | 12-30 | 75-150 | 120-150 |
| **Line Capacity** (passengers/direction/hour) | 5000 - 45000 | 12000 – 27000 | 40000 - 72000 |
| **Maximum Speed** (kph) | 60-70 | 60-80 | 70-100 |
| **Average Capital Costs**[1] (2000 US$/km) | 8.4 | 21.5 | 104.5 |
| **Average Operating Cost**[1] (2000 US$ per vehicle revenue km) | 2.94 | 7.58 | 5.30 |

*Notes*
1. Costs figures are for US case studies. Costs adjusted to $2000, calculated using Consumer Price Index average.
Sources: Levinson et al., (2003); Vuchic (2005); Hensher and Golob (2008); Zhang (2009); Deng and Nelson (2011)

*Table 8 Comparison of BRT and Urban Rail systems (Cervero 2013) 17*

A similar investigation was conducted [Vuchic et al. (2013); Nelson & Ganning (2015)] which was more extensive in terms of types of public transport systems considered. This is summarised in the Table below.

[17] Cited in University of Sydney Working Paper 5: International learning on Network Planning and its contribution to ‘Perth and Peel 3.5 million’

| Mode | Bus | Bus Rapid Transit | Guided Bus Transit | Light Rail Transit |
|---|---|---|---|---|
| | *Mixed traffic* | *Median or grade separated* | *Kerb or rail guided* | *Median or grade separated* |
| Spatial requirements | Low | High | Medium | Medium |
| Aesthetic amenity | Low | Medium | High | High |
| Peak line capacity (ppdph) | 5,000 | 7,200-20,000 | 7,200 | 12,200-27,000 |
| Vehicle capacity (maximum) | 100 (double decker) | 230 (Phileas) | 255 (Translohr) | 420-600 (60-98m vehicle) |
| Average operating speed² (including stops) | 15-20km/hr | 25-48km/hr | 25-35km/hr | 25-55km/hr |
| Capital investment ($NZ/km) | Low | $29-78m/km | $37-42m/km (kerb-guided) $61m/km Translohr | $31-120m/km |
| Operating costs | Efficient below 1,500 ppdph | Efficient between 1,500-2,800 ppdph | | Efficient above 2,800 ppdph |
| Land development impacts | Low | Residential value increase 2.2-10% Commercial value increase 25% | | Residential value increase 6.5-17% Commercial value increase 72-120% |

*Table 9 Comparison of transit technologies[18]*

It is apparent from the comparative Tables above that there are proven alternatives to light rail that meet the required performance criteria – more so for some of the criteria.

**Emerging Technology**

The Tables above both summarise the relative costs, capacity and performance of different transit technologies. However, not included in those investigations is a category of public transport system that sits between light rail and BRT. This being an emerging technology that can best be broadly referred to as Guided Electric Transit System (GETS). It is noted that the Guided Bus Transit technology considered in the investigations by Vuchic et al. (2013) and Nelson & Ganning (2015) is different from that of Guided Electric Transit System (GETS). The GETS brings together proven technology with quick charge electric vehicles released in July 2016 (post the evaluation studies cited above). Guided vehicles such as Translohr and Phileas represent an evolution of the technology and have some common attributes to the GETS such as station stops, being electric or hybrid electric, on road rubber tyred and having a light rail like appearance. The guidance systems referred to in the Table above are concrete kerb similar to the Adelaide O-Bahn and steel rail guidance.

[18] Adapted from Vuchic et al. (2013), Nelson and Ganning (2015) cited Centre for Infrastructure Research, University of Auckland, University College London, Volterra Partners Llp and Synergine Emerging Technologies for Rapid Transit: Part One Future-proofing Investment Decisions Jan 201

That is, GETS is a new high-order transport system with features suited to Parramatta Road that include computer based guidance system, on-route quick electric charging options (15sec), and light rail type vehicle with higher passenger capacity. A GETS has a form (vehicles and associated infrastructure) akin to and so perceived as equivalent to light rail.

It is therefore apparent that a GETS can provide the required performance criteria and the same sense of permanence and so confidence as provided by light rail. Significantly a GETS is a far more cost-effective public transport system[19].

**Depots**

An additional advantage of the BRT or GETS vehicles is that they can utilise the available depots and are not reliant on finding a site connected to the route. However the WestConnex storage shed for the M4/M5 project also provides an ideal site for the depot for all modes due to its close proximity and accessibility. The State Transit Depot at Leichhardt has the facilities and accessibility to suit the BRT or GETS vehicles, however availability of spare capacity is uncertain at this time.

## 5.2 Initial cost comparison of Light Rail vs GETS

The indicative cost estimates for light rail and GETS are based on previous studies both in NSW and internationally and are presented for comparative purposes. A more accurate cost estimate would require engineering design and assessment outside the scope of this study. The comparative costing is based on centre-running along Parramatta Road as this configuration preserves the option for a staged approach to implementation and future light rail. The route is 14.6km from the CBD to Strathfield or 20 kilometres from the CBD to Parramatta. It has 8 precinct super-stops as identified in the Parramatta Road Urban Transformation Strategy where interchange can occur. Frequency is estimated at 5 minute intervals. Individual vehicle capacity is 150 and vehicle length is 18 metres or 24metres providing appropriate inner city scale suited to block length and urban environment.

The Table below provides comparative cost of light rail/tram, tram buses and GETS[20] . The information has been sourced from a study undertaken in 2014 by the Canadian Government the vehicle and charging infrastructure is an older technology than being proposed as the charging infrastructure and fully electric vehicle utilizing on route charging had not been released. However the table provides useful comparative costing. Supplementing this information is an indicative quote from Van Hool for state of the art of the vehicles (released July 2016), charging infrastructure and commissioning it includes the new fully electric Van Hool vehicle and Siemens quick charging and depot charging equipment.

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[19] [19] It is noted that an investigation *["Report to City of Sydney: Integrated Transport Strategy – Mass Transit for CBD and Inner Sydney"*; Glazebrook et al; February 2005] concluded that light rail is to be preferred to guided bus technologies for Sydney. However, since that investigation (over a decade ago) there has been significant advance in the development and deployment of such alternate public transport systems. It may be the case that the conclusion of the earlier (Glazebrook et al) investigation has persisted and not been challenged in terms of key decision-makers. In that regard the research by Hensher et al (2015) is relevant (as cited by Mulley; 12 December 2015).

[20] A trambus is an electric, articulated higher capacity, multiple door, low floor and internally configured bus that looks like a tram

| Project Costs $million | Tram | Trambuses | GETS |
|---|---|---|---|
| Station Cost | $ 25.00 | $ 25.00 | $ 25.00 |
| Vehicles | $ 60.00 | $ 20.00 | $ 20.00 |
| Guidance system | 0 | 0 | $ 1.25 |
| Land acquisition | | | |
| Depots and workshops | $ 10.00 | $ 2.00 | $ 2.00 |
| Road/track works | $ 125.00 | $ 37.50 | $ 37.50 |
| Relocation of services | $ 25.00 | $ 3.75 | $ 3.75 |
| **Sub-Total** | **$ 245.00** | **$ 88.25** | **$ 89.50** |
| Design &Project Management | $ 61.25 | $ 22.06 | $ 22.38 |
| **Total** | **$ 306.25** | **$ 110.31** | **$ 111.88** |

*Table 10 Cost Comparison*

Note: Per kilometre cost for tram/light rail is $15.31m, trambus $5.51 and GET $5.59m

The table above is intended to provide a comparative guide only. It is noted that a cost estimate provided by Van Hool for the latest quick charge electric vehicle technology has the cost of the vehicles and the charging infrastructure roughly equivalent to the vehicle only cost of light rail. Overall in this scenario the cost of GETS is significantly less than light rail.

It is likely that the GETS option minimises the risk of unforeseen cost escalation through not requiring land acquisition or services to be relocated due to running in the existing corridor already is accommodating articulated buses. Operating and maintenance cost are reportedly less for an electric vehicle than for light rail or diesel bus.

As part of the renewal program it is anticipated that the road pavement and footpaths would be upgraded and repaired. With the GETS option the works could be staged to include upgrades around stations (as eluded to in the PRUTS) with a recoloured and line marked road pavement between precinct nodes. If a road embedded charging infrastructure is selected over the totem station charger the implementation cost may increase significantly. The embedded charging system does have advantages that are discussed under vehicle technology.


CBD&SE Urbos3 Northern Beaches BRT ExquiCity electric vehicle

## Cost of Light Rail in Sydney and Canberra

The final stage 5.6 kilometre section from Lillyfeld to Dulwich Hill of the Inner West Light Rail line was completed in 2014 at the total cost of $176m. This equates to $31.42m per kilometre much more than the anticipated cost of $20m per kilometre. The Inner West Light

Rail carried 6.1m passengers in 2015 and has attracted a significantly higher ridership than anticipated. The total line is 12.8 kilometres in length and has 23 stops. The vehicles used are the Urbos 3 which are 18m long and carry between 128 - 327 seated or standing passengers. It has 8 doors across 2 articulated sections. The route was constructed mostly on the old goods line.

The cost the CBD and South East light rail is currently estimated at $183.3m per kilometre a total of $2.2b for 12 kilometres and 19 stations. The significant high initial cost and cost overruns are due to changes in design, compensation requirements, land acquisition, services relocation and upgrades and delays.

The cost of the Parramatta Light Rail was projected to cost $1.5b ($50m per kilometre) but is now estimated at $3.5b. Since the announcement of the Western Metro in this project has fallen in construction timing priority with the Western Metro being announced. The Parramatta light rail was to be stages 1and 2 of the Western Sydney light rail network. This initial stage consisted of approximately 30 kilometres of rail, 20 vehicles running at 10 minutes frequency.

In Canberra the 12 kilometres City to Gungahlin route was estimated to cost between $300 to $360 million for BRT or $25m -$30m per kilometre and the cost of light rail $700 to $860 million or $58.3m to $71.66m[21]. Of this total cost 32% for BRT and 24% for light rail was for planning and design. There was no cost associated with vehicle purchase for BRT but 20% was allocated for light rail.

### Cost of BRT Northern Beaches line B-Line

The B Line scheduled to start operating in late 2017 it will provide new double decker busses running at 5 minute frequency. The project was originally estimated to cost $305m in 2014 but the cost has escalated to $512m as announced in the 2016 State budget. The reason for the increase has been primarily due to land resumption costs associated with the 6 commuter carparks along the route.

### Other international Cost Comparisons

The cost estimate for the Rouen electric BRT line with overhead wire was $122m ($7.65m per kilometre) for a 15-vehicle, 16 kilometre, 20-station system. This included $38m for vehicles and system implementation, $59m for construction and $25m for engineering and design. The comparative costs for a light rail line was estimated to be $495 million, or $31m per kilometre.

### The Cost Estimate for GETS and Charging Infrastructure

For the purposes of this Study Van Hool provided an estimate for the provision and installation of the new Exqui.City fully electric vehicles. This includes the option to have 18m (same length as the Inner West light rail vehicles) or 24m vehicles. The Exqui.City electric vehicles were released in July 2016 and have a quick charge (15 seconds) at some station stops and a slow charge at the depot at the end of the day.

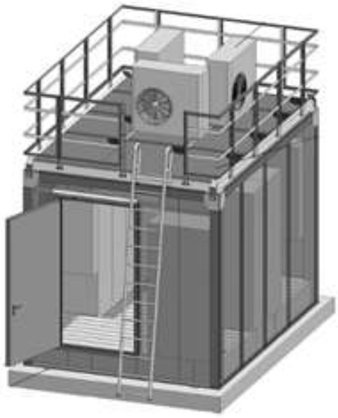
The 18m vehicle is approximately $1.4m and the 24m vehicle is approximately $1.72m.

[21] URS *City to Gungahlin Transit Corridor: Concept Design Report (April 2012)*

A lead time for delivery of the first vehicle in Australia is 24 months after signing of a contract with vehicles delivered 1 per week subsequently.

An approximate cost for the charging infrastructure for 30 vehicles on a 20 kilometre route is $7.16 m this includes 8 Pantographs of 250 kW station chargers and 30 Depot chargers of 25 kW for each bus. This cost includes complete project execution minus the cost of the 400V connection from the grid to the containers.

- 30 full electric 24m Exqui.City vehicles x 30 $51m:
- Charging infrastructure $7.16m
- Guidance system is $1.87m
- Total vehicle and associated infrastructure cost is $59.03m.



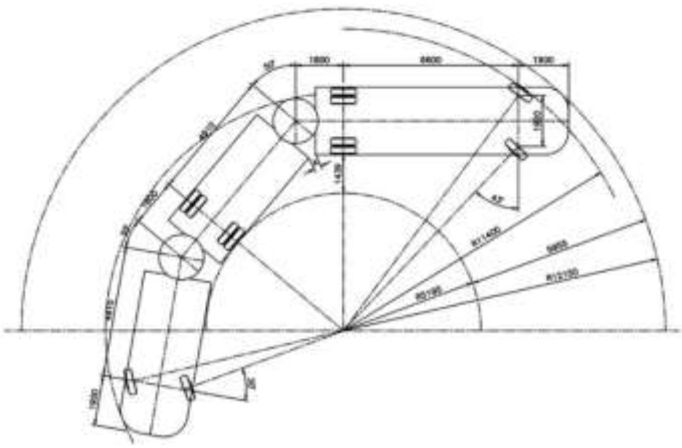
Opportunity charging:
8 pantographs 250 kW including electric steering, winter package, packaging and transport to Australia.

4 Containers TSR-42.32-ISO B for the pantographs (inside the container are the electrical cabinets), and 8 KRATZER 250 kW charging systems. Including control units, transport and commissioning, installation and documentation. Commissioning of the charging system in Australia CE-certification for the 250 kW system

Night charging:

30 charging totems of 25kW for night charging 1 for each vehicle. Including packaging and transport to Australia.

The vehicles articulation enables manoeuvring in existing streets and around obstacles if needed and provides an opportunity for express services with passing lanes.



## 5.3 Vehicle Type & Technology

***'As new technologies emerge, it is crucial to future-proof investment decisions for urban transit. There is a risk that current investment decisions 'lock in' technologies that may be superseded in coming decades.'[22]***

The Joint Modelling Application Centre (JMAC) commissioned in 2016 a report to inform the New Zealand government's future public transport infrastructure investment. The two part report *Emerging Technologies for Rapid Transit* was prepared by the Auckland Centre for Infrastructure Research, a collaboration of University of Auckland, University College London, Volterra Partners LLP and Synergine. *Part One: Future-proofing Investment Decisions,* dated April 201, evaluated current technology and undertook a literature review on Bus Rapid Transit (BRT) and Light Rail Transit (LRT) systems. The technology review summarized current and emerging technologies for various dimensions of rapid transit, including vehicle design, power sources and transmission, and control systems.

This JMAC report found that:

- There is convergence in BRT and LRT modes, such as ride quality, peak line capacity and energy sources:
- New technologies are improving the vehicle capacity and ride quality for BRT vehicles, speed and accessibility of LRT vehicles.
- It anticipates that electric or hybrid vehicles will become standard for BRT in the medium term.
- The advantage offered by LRT are development uplift, mode shift, operating cost efficiency, peak line capacity and speed.
- The advantages of BRT is providing lower visual impact, low initial cost, high-capacity and flexible services.

*Part Two: An Evaluation of Specific Technologies* released in July 2016, evaluated several emerging technologies to understand their likely future trajectory, and impacts on the forecast costs and benefits of different investment options. The study employed scenario modelling to test if emerging technologies would shift the value proposition between LRT and BRT.

The Scenario testing of new technologies undertaken by the JAMC study found:

- The development potential of Connected and Automated Vehicles (CAV) technologies is not estimated to affect the viability of mass transit modes until 2055; at which point an estimated 50% vehicle fleet may operate autonomously.
- In scenarios of both low and high technological development, the lack of demand acts as a limiting factor and a risk-averse perspective suggests that lower cost BRT options are more appropriate.
- Scenarios of high demand produce different risks, and selecting the most efficient and high- capacity mass transit modes is preferable to match the high level of transit demand.

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[22] Centre for Infrastructure Research, University of Auckland, University College London, Volterra Partners LLP and Synergine

- If technological development is high, the optimal solution may utilise both BRT and LRT, to provide complementary services with a better tradeoff between capital cost and benefits generated.
- The development of autonomous or semi-autonomous systems reduce the need for driver interventions and can increase the density of vehicles (hence passenger journeys) per kilometre of road or rail. These are being widely tested and are likely to produce semi-autonomous vehicles within five years. They will focus on crash avoidance, increased vehicle density and interchange management.
- The long-term uptake of technologies for micro-transit and new forms of shared automobile travel, depends largely on the response of transport regulators and planners to regulate and cater for new forms of transit on the existing networks. The relative prioritisation of mass transit, micro-transit, private vehicles and active modes is a key factor for the reliability and travel time of each mode.
- For efficient operation of the overall transport system, the optimal combination of different modes ensures that modes are matched to commuter flows; high capacity corridors are best served by mass transit, while micro-transit has significant potential for last mile trips.
- Since both BRT and LRT are inflexible design of mass transit networks may consider the complementary role of micro-transit to optimise the transit network's effective service coverage.

### High capacity rapid transit: Light rail and bus rapid transit

The following table provides the definition of BRT. In the Parramatta Road context with kerbside running, onboard ticket validation and modest shelters it would be considered as BRT-Lite

| | Full Service BRT | "BRT-Lite" |
|---|---|---|
| Running ways | Exclusive transit-ways; dedicated bus lanes; some grade separation; | Mixed traffic; modest intersection treatments |
| Stations/stops | Enhance shelters to large temperature-controlled transit centres | Stops, sometimes with shelter, seating, lighting and passenger information |
| Service design | Frequent services; integrated local and express services; timed transfers | More traditional service designs |
| Fare collection | Off-vehicle collection; smart cards; multi-door loading | Fares paid upon boarding |
| Technology | Automated Vehicle Location; traffic signal preferences; vehicle docking/guidance systems | More limited technological applications |

*Table 11* Full Service BRT and "BRT-lite" systems, adapted from Cervero (2013)

*Investment decisions should carefully consider the desired outcome and associated benefits – whether the aim is to develop a system that delivers access to different areas or a linear transit route… The long term impacts of investment, and the role of transit investment in supporting growth is significant.(JMAC 2016)*

**Safety, reliability and environmental performance**
The safety of LRT and BRT systems is largely dependent on the network layout. While most issues emerge from the design and geometry of traffic corridors, rather than the specific technology (Goh et al., 2013), differences between bus and rail transit emerge with regard to braking rates and the management of conflict points along the transit corridor (Vuchic, 2007). Buses tend to have a higher braking rate, which reduces the risk of collision with pedestrians, however corollary to this is an increased risk to bus passengers from sudden stops. The guided electric vehicle in a dedicated corridor will provide the safety of the light rail and the ride experience with assisted docking for smooth arrival and departure form station stops. Technology advancements in collision avoidance will also improve safety for road based vehicles.
Impacts on noise, air quality and reduced carbon emissions are significant for both LRT and BRT technologies due to the advantages associated with the new fully electric vehicles.

**User experience and perceptions**
*The qualitative aspects, including the aesthetics, comfort, and user perceptions of transit services are important to induce mode shift, particularly from private vehicles to transit.*[23]
These elements not only depend on the choice of technologies and design of transit infrastructure but on integrated system provision and management and frequency, landscape, urban form and complementary "place-making" investments.
*Empirical research, based on both survey data and the actual preferences, suggests that, focusing solely on quantifiable service characteristics such as travel time and cost, there is no emergent passenger preference expressed between BRT and LRT, however when qualitative aspects are accounted for, there is a bias toward rail*[24] *(*

With the convergence of technologies there is a narrowing in the qualitative differential between BRT and LRT systems.

**Established and Emerging Technologies**
The JMAC report reviewed established vehicle technologies, including the O-Bahn Kerb Guided Bus, Bombardier GLT (Rail Guided Electric Bus), Phileas (Magnetic Guided Electric Battery Bus), Alstom Translohr (Rail Guided Electric Battery Bus), and Siemens Optiguide (Optical Guided Bus). The study found that the key advantage of a guided bus system, over manual operation, is that guided buses may offer a smoother ride quality than manually operated buses and are able to run in a narrower corridor. The Study also found that many of these guided buses (trambuses) were nearly as expensive as light rail due to the infrastructure requirements rail, power and platforms and the proprietary nature of the systems.
The GETS does not have the expense of rails and overhead wires rather the charging is confined to station stops. This is cost effective and less visually intrusive. The range and performance reliability of guidance systems is changing rapidly and there are now choices available (additional to the Siemens option mentioned) that would provide smooth and

[23] *Deng and Nelson, 2010; Rabinovitch and Hoehn, 1995*
[24] *Cain and Flynn, 2009*

accurate docking at stations improving ride quality and safety. The GETS will not be dependent on propriety systems hence reducing cost and providing greater system adaptability and resilience.

> *"Buses the world over have proved themselves the most modern and efficient type of public transport, and have superseded trams in all important overseas cities. Buses are far more mobile and get away from the rigid tracks. Buses will certainly speed up vehicular traffic and eliminate bottlenecks. The lifting of tram tracks will remove a constant source of danger to vehicular traffic both in wet weather when rails cause skids and when tracks are in a neglected state and develop potholes."*
>
> **Mr H E Richards, National Roads and Motorists' Association (NRMA ), quoted in 'No new trams for Sydney; gradual change to buses', 10 November 1953, newspaper clippings scrapbook, Sydney Tramway Museum Archive.**

Sydney tram 1953.

**Connected and Autonomous Vehicles (CAV)**

Technologies enabling vehicle-to-vehicle communications can improve the ride quality and efficiency of transit provision. Specifically, platooning functions that enable vehicles to travel together, connected by wireless communication. A lead vehicle is operated manually, while a number of follower vehicles are actively co-ordinated to the lead vehicle and follow at close proximity.

It is envisage that the evolution of this technology would enable vehicles to travel in close proximity (platooning) and that this could further improve line capacity.

**The Last Mile**

The 'last mile' problem is a challenge for urban transit and if these trips are poorly provided for, it can create significant barriers to transit use. So it is important to understand the alternative transit options to provide access for commuters that will use the Parramatta Road spine system.

New technologies are emerging with complementary modal options to provide for first and last-mile connections including:

- On-demand feeder buses
- Walking and cycling infrastructure
- Bikeshare systems and/or electric bicycles
- Rideshare apps
- Carshare
- Park and ride infrastructure
- Autonomous vehicles.

As these options develop further there is also potential for them to compete with the mass transit services.

The Cristal pictured below is an example of CAV technology suited to last mile travel. The vehicle developed by Translohr is currently being trialed in Berlin. Perth also is trialing an automated driverless shuttle bus. There are successful examples of pod type vehicles n current operation including the Morgantown PRT (West Virginia USA) in service since 1976 and the London airport shuttles. The Inner West region of Sydney has areas particularly suited to this transport mode especially if a 'spine and spur' network is developed.

This technology has previously been bespoke and expensive due to the infrastructure and management requirements but with technological advancements making these more affordable it is considered these could rapidly become commonplace. The JMAC report very conservatively predicted that 50% of the public transport fleet could be comprised of this mode by 2055.


Image: Last mile vehicles example the Cristal currently being trialed in Berlin

**Power sources and delivery**

*Power sources and delivery systems have advanced for both LRT and BRT technology, and there is high potential for electric buses to become standard vehicles for BRT systems. The current cost premium for electric buses, which is approximately twice the capital cost of conventional vehicles, is expected to fall. Technology for hybrid diesel electric buses is established and reliable, however the review suggests that battery electric buses have higher development potential. Newer fuel sources using hydrogen fuel cells have been*

*trialed, however hybrid or electric buses have superseded this technology in most cases. Investment into bus transit may need to consider whether to take on a higher vehicle cost for battery electric buses, against the lower cost and more reliable hybrid technology. The volatility of electricity and diesel fuel prices may also be relevant to understand long- term operating costs. (JMAC 2016)*
Of note is the electric vehicles and charging technology released in late 2016 were not considered in the JMAC report quoted above.

**Control systems**
The GETS has the ability to incorporate intelligent transport systems, semi-autonomous control and crash avoidance technology as it becomes proven. The advantage of this emerging technology is that is being developed widely so reducing the costs and risks of adopting propriety systems and infrastructure.

**Convergence**
*The information gathered from transit manufacturers highlighted vehicle capacity improvements for both BRT and LRT, and a tendency toward international standardisation of vehicle design. While the emergence of "rubber-tyred trams" shifts the physical form and ride quality of bus transit toward that of light rail, the additional cost of vehicles and requirement for fixed guiderails eliminates any cost or flexibility advantage for BRT. (JMAC 2016).*

For Parramatta Road it is likely that the cost will be significantly less due to the ability to run in an existing corridor without guide rails hence without the need to relocate services as for light rail. Recently the cost for light rail in NSW has been more than expected with a portion of cost overruns attributed to the need for redesign and services relocation or upgrade.

Presently there are a range of technologies at trial stage or low-level implementation and it is difficult to anticipate which of these may develop in the future for widespread use and what new technology will emerge. Strategic investment planning must identify where technology offers benefits and potential risks to the transport network's capability and ensure that the adoption of new technology is appropriately managed to lock in the benefits and safeguard against potentially detrimental effects.

# 6 EVALUATION and IMPLEMENTATION


## 6.1 Public Transport Option Evaluation

The following section provides an evaluation of the public transport options for Parramatta Road. It utilises the place and movement criteria based upon an understanding of the process and role of urban transformation and the site specific characteristics of Parramatta Road and the types and configuration of public transport suitable. Additionally consideration is given to the constructability aspects of cost, engineering and staging.

It is noted that the various options considered were assumed to have the following characteristics.

- BRT – is kerbside and utilises either the double decker bus of the B line or the current articulated buses in use (not fully electric vehicles).
- LRT - is centre running, the vehicle is the Urbos 3 type as used currently and has catenary overhead wires
- GETS - is an electric, guidance technology and is a 24 metres vehicle. The GET is centre running.

### Multi Criteria Assessment

The public transport options for the Parramatta Road corridor were evaluated using Multi-Criteria Assessment (MCA). The results of the evaluation, including a discussion on the results of sensitivity tests for the evaluation, are presented below Appendix E.

### Evaluation Criteria

Evaluation criteria were formulated so that a balanced evaluation of the proposed public transport options for the corridor could be achieved. These were developed during stakeholder workshops and refined by the study team. The categories that were chosen for the evaluation criteria reflect the place and movement paradigm but also included the element of constructability.

| Criteria |
| --- |
| **Movement** |
| Moving people from place to place efficiently |
| Providing a range and interconnection of transport modes |
| Higher passenger capacity per lane per hour |
| Adaptability and agility (avoids breakdowns) |
| Access for utilities and services |
| Access for emergency response and deliveries |
| Safety providing a safe environment for movement in all modes |
| Provides for north south as well as east west movement |
| Improved connectivity between places |
| Accommodates and encourages high level of pedestrian activity |

Allows for short term parking and loading
Accommodates cycling infrastructure
Provides places for car share facilities
Supports intended road function -arterial
Corridor preservation for 5 light rail
Future proofing and preserving future opportunities
Mode and service integration
Traffic management
Services the needs of adjoining land use
Meets future transport demand

**Place**

Suited to current conditions and transitional aspirations
Improves social connectivity
Strengthens place identity
Limits impacts of construction on community and business
Reduces emissions
Reduces noise
Enables greening the corridor
Reduces heat island impacts
Caters for increased housing supply
Support increases in local employment
Increases business activity and viability
Accommodates and encourages high level of pedestrian activity
Allows for short term parking and loading
Assist to create high amenity of the public realm
Suited to customer preference and convenience
Heritage conservation
Adjoining land use

**Constructability**

Suited to the physical environment
Meets and identified need
Fit – road width and gradient
Network integration
Safety
Cost of implementation – route construction and vehicles
Reduces need for services upgrade and relocation
Resilience
Timeliness – lead time to operation
Day one implementation
Flexibility and futureproof,
Program of works integrated with other construction projects
Progressive implementation
Suited to staged construction
Construction impacts and duration
Politically acceptable
Demonstrates commitment to quality public infrastructure
Broadly supported by community and stakeholders

### Sensitivity Testing

To test the sensitivity of the evaluation a pair wise comparison of criteria was undertaken. This generates a weighting for each criterion. The pair-wise comparison technique compares each of the criteria against each other sequentially. For example, criterion A is compared against criterion B in terms of which criterion is "preferred" over the other one. A 'value' for this level of preference is then assigned to this comparison.

The pair-wise process then generates a series of 'weightings' for the criterion.

The resultant criterion were each grouped under one or other of the following categories and the weighting are presented below.

| Goals, desired criteria, function and features | Pairwise Weight |
|---|---|
| **Movement** | **14%** |
| Supports mode shift | 5 |
| Allows continued arterial road function | 9 |
| **Place** | **18%** |
| Achieves urban transformation economic goals | 9 |
| Achieves urban transformation social objectives | 9 |
| **Constructability** | **68%** |
| Affordable | 27 |
| Timeliness | 41 |
| **Total** | |

The percentage weightings nominated below are the 'baseline' score and the weighting after pairwise comparison. This shows that although movement was the most influential criteria originally in the choosing the preferred mode this changed when a pairwise comparison was undertaken and constructability was thought more important.

Because the GETS had scored higher against all categories the changed weighting does affect the result and the GETS is still the preferred mode. However, it did impact the second choice where light rail had been preferred over BRT and this was reversed as cost and ease of implementation became the most influential criteria influencing selection.

*It should be noted that this evaluation was a high level desk top assessment and that further rigor will be provided through technical and feasibility studies[25].*

[25] *Also of note is that subsequent to completion of the initial Study additional research was undertaken. This concerned a comparative analysis of the Rapid Bus Service (RBS) and the Guided Electric Transit Service (GETS). The RBS is that currently proposed by the NSW Government through its Agencies and the GETS is that identified in the initial Study as an alternative (to Light Rail and the RBS) worthy of further more detailed investigation.*

*The additional research is detailed in an* ***ANNEXURE*** *to the Study Report.*

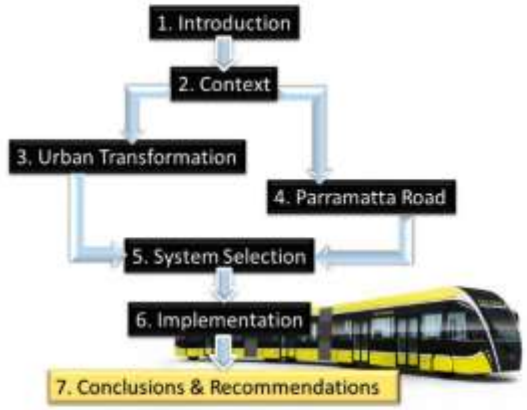
## 6.2 Implementation

In addition to the committed funding for public transport improvements along Parramatta Road there are opportunities for funding that could be provided by using local level value capture through to region-wide infrastructure levies. It is likely that a hybrid of these methods could be employed with the station infrastructure funded through value capture mechanisms relating to redevelopment in the vicinity of the particular station. The remaining capital construction, vehicle purchase and any operating subsidies could be covered by a regional transport levy or hypothecated land/property rates. This approach to funding is equally applicable to light rail and GETS. However, GETS is of significantly lesser initial (capital) cost and so the funding mechanisms would be more readily accepted. Also, GETS offers greater system resilience, construction and operational flexibility and a much earlier start. The overall implementation for GETS as compared to light rail is shown in the Gantt Chart below.

| Stage and Option | 2016/ 2017 | 2018 | 2019 | Post 2023 |
|---|---|---|---|---|
| **GETS Option** | | | | |
| Stakeholder engagement | | | | |
| Funding model | | | | |
| Enabling Agreements | | | | |
| Technical and Urban Design | | | | |
| Vehicle procurement (for delivery 2019) | | | | |
| Investigate Network options- | | | | |
| Build lanes and stations | | | | |
| Introduce GET's | | | | |
| **Light Rail** | | | | |
| Stakeholder engagement | | | | |
| Funding model | | | | |
| Enabling Agreements | | | | |
| Technical Design | | | | |
| Landscape and Design | | | | |
| Vehicle procurement | | | | |
| Network options- Iron Cove Victoria Road spur | | | | |
| Build lanes and stations | | | | |
| Landscape improvements | | | | |
| Open light rail to CBD | | | | |
| Landscape | | | | |
| Investigate network expansion Great North Road | | | | |
| Connect Concord | | | | |

An indicative cost estimate of Light Rail along Parramatta Road (from Sydney CBD to Strathfield) is $750M. Inclusive of 'loops' to Burwood and Strathfield Heavy Passenger Rail Stations estimated cost is $1B. It should be noted that these cost estimates are based on a preliminary conceptual view and are for capital construction cost only – rolling stock and operating costs are additional. The capital construction cost of GETS is estimated to be less than a third that of Light Rail. The cost of vehicles and operating costs are comparable to Light Rail.

# 7. CONCLUSIONS and RECOMMENDATIONS




The opportunity to initiate the transformation of Parramatta Road to become *"**a living street: a corridor of enterprise**"*[26] has arrived. It is imperative that it be actioned as a matter of the highest priority given that the opportunity may well be short-lived. This is a consequence of the transformation requiring quite fundamental change to its transport role. Yet it is apparent that the significance of such a change in role is not well appreciated given that other transport initiatives evidence a clear intention for Parramatta Road to remain a major conduit for private vehicle use. To delay is to risk having these other transport initiatives diminish the full suite of benefits available from true transformation. A practical approach that accommodates private vehicle use consistent with urban transformation has been determined but for it to be useful requires early and assertive advocacy by Councils and active responses by State and Federal Government.

The Parramatta Road Urban Transformation Strategy requires an appropriate dedicated public transport system that does not compete for available road reserve space with private vehicles nor with the heavy passenger rail service. Such a system provides the catalyst for integration of transport and land-use at a local precinct level consistent with the transformation strategy.

The urban transformation strategy advocates initial use of kerbside running of Bus Rapid Transit (BRT) with the possibility of Light Rail some considerable time off (in the order of 20 years). A kerbside running BRT system will likely convey a 'business as usual' sense to community and investors and so not provide the catalyst to effect the desired urban transformation. Indeed the current kerbside-running of buses in priority bus-lanes precludes the short-term parking necessary for reactivation of street fronting retail and commercial businesses.

Whilst Light Rail is consistent with the required performance criteria it has the distinct disadvantage (in addition to cost) with regard to Parramatta Road of not being able to be implemented for some time. This will result in unleashing of latent demand for private vehicle use along Parramatta Road. There are also risks associated with selection of a transport mode that may be unsuited to emergent transport technology and social change.

It is imperative that detailed investigation and design to accommodate a GETS public transport system proceed post-haste. The urgency relates to the imperative to stave-off the significant risk of Parramatta Road succumbing to the unleashing of latent demand of private vehicle use consequent to WestConnex. Also, it is important to demonstrate early commitment to investors and the broader community to the urban transformation strategy.

[26] WestConnex Urban Renewal Framework Hassell 2013

The Inner West Council and the City of Canada Bay have taken the initiative through this Study to contribute from a well-informed basis to effecting the transformation of Parramatta Road. Also to contribute to the creation of an integrated public transport network to serve the inner west communities. In that regard this Study can provide useful input to deliberations relating to the proposed Parramatta to Strathfield light rail.

The next steps concern undertaking collaborative investigation and design studies. This collaboration is important in going forward as all directly impacted Councils will have an important role in implementation and are also best placed to incorporate community aspirations and needs within the urban transformation program. Ideally this lead role should be in concert with other local government authorities that have an interest in the transformation of Parramatta Road.

Overall an appropriate public transport system can be achieved through a Guided Electric Transit System (GETS) as a viable alternative to Light Rail. Significantly it provides opportunities for staged and lower cost implementation. An initial stage would be at 'Day One' of WestConnex Stage 3, Part 1. GETS is the integration of a series of proven technologies that would create opportunities for Australian leadership in its further development and deployment.

The GETS was also determined to be preferable to the Rapid Bus Service (RBS) currently proposed by the NSW Government through its Agencies. The comparative analysis underpinning this conclusion is presented in an **ANNEXURE** to the initial Study Report.

**This Study recommends**:

- Centre-Running GET vehicles from ***day one of WestConnex Stage 3 Part 1***
- Provision of short-term kerbside parking outside peak periods
- Preservation of the corridor for mixed fleet GET
- Pursue opportunities for a 'spine and spur' network
- Councils to work collaboratively with State and Federal governments to progress the project. Noting that local government is well placed to gauge community aspirations and need.

**Next steps**

The preferred next step in this project would be the establishment of a collaborative approach between all levels of government to progress a feasibility study. This would provide a detailed assessment of the viability of a Guided Electric Transit System (GETS) system for Parramatta Road capable of being introduced to coincide with the opening of WestConnex Stage 3 Part 1 (if approved). Also of it being configured for centre-running and providing kerbside parking (at least outside of peak periods). Consideration should also be given to arrangements that would enable (as required) for the new GET public transport system to support the short-term inclusion of existing buses running in a mixed traffic environment.

**The basis for such a productive collaborative approach is a comprehensive and shared understanding of a GETS.** It is apparent that this has not yet been achieved and to this end a series of briefings of the decision-makers and other key stakeholders is an imperative pre-requisite step. Such briefings could usefully incorporate intelligence gathering visits to other jurisdictions in the form of a public-private joint technical tour.

This Study is cognisant of significant recent commitments made to invest in light rail in the Sydney urban region and has considered the importance of an integrated network. It has also given consideration to the staging, development and cost impacts of retrofitting light rail in an urban environment. The system agility and opportunities presented by the very recent technology advancements should not be ignored. **With emerging technology there is a state of flux and this should be 'embraced and shaped' to provide the best of advantages to current and future generations of Sydney.**

In the language of the Roadmap the GETS provides opportunity for putting in place **'<u>no regrets</u>'** technology and infrastructure. Thus reserving the corridor and the agility to respond to change and accommodate future uses be that light rail or other transport innovations.

# REFERENCES

Note: References are identified throughout the text and associated Tables and Figures. The more generally applicable references used for the Study are listed below.

Australian Bureau of Statistics, Dwelling Structure Parramatta Road Corridor, ABS Census 2011

Australian Bureau of Statistics, Motor Vehicles per Dwelling - Parramatta Road Corridor, ABS Census 2011

Bureau of Transport Statistics, Household Travel Survey Report 2012/13 Transport for NSW, December 2014

Bureau of Transport Statistics, TfNSW BTS Travel Zones, 2011 Journey to Work Tables 12 and 13 based on the 2011 BTS Travel Zone (TZ) and 2011 Australian Standard Geographical Classification (ASGC) Standard Area 3 (SA3) boundaries, data accessed September 2016

Centre for Infrastructure Research, University of Auckland; University College London, Volterra Partners Llp and Synergine, "Emerging Technologies for Rapid Transit: Part One Future-proofing Investment Decisions", January 2016.

Centre for Infrastructure Research, University of Auckland; University College London, Volterra Partners Llp and Synergine, "Emerging Technologies for Rapid Transit: Part Two "An Evaluation of Specific Technologies", July 2016.

Department of Planning and Environment, A Plan for Growing Sydney, Government of NSW, December 2014

Glazebrook et al; "Report to City of Sydney: Integrated Transport Strategy – Mass Transit for CBD and Inner Sydney"; February 2005.

Greater Sydney Commission, Towards Our Greater Sydney 2056, November 2016

Greater Sydney Commission, Draft Central District Plan – Co-creating a Greater Sydney, November 2016

Hassell, WestConnex Urban Renewal Framework, 2013.

Luke, S., Public transport mode selection: a review of international practice. *European Transport Conference,* Strasbourg, France, 2006.

McKibbin, M., Understanding the benefits of light rail projects in NSW. Technical report, Transport for New South Wales, 2015.

MKI Business Case: Downtown Ottawa Transit Tunnel Project - Tunney's Pasture to Blair Station via a Downtown LRT Tunnel. Technical report, City of Ottawa, 2010.

Munoz-Raskin, R., Walking accessibility to bus rapid transit: Does it affect property values? the case of Bogotá, Colombia. *Transport Policy*, 17:72–84, 2010..

Mulley, C., Working Paper 5: International Learning on Network Planning and its Contribution to 'Perth and Peel 3.5 million', University of Sydney, 12 December 2015.

Newman, P.; Jones, E.; Green, J.; & Davies-Slate, S.; "Entrepreneurial Rail Model: A Discussion Paper"; Curtin University; February 2016.

Nelson, A. and Ganning, J., National study of BRT outcomes. Technical report, National Institute for Transportation and Communities, 2015.

Northern Ireland Assembly, A Rapid Transit Network for Belfast Metropolitan Area - Summary of Key Findings. Technical report, Department for Regional Development, 2008.

NTL (2016), http://www.newtl.com/en/a-safe-guiding/, accessed March 6, 2016.

Rabinovitch, J. and Hoehn, J., A sustainable urban transportation system: The ”surface metro” in Curitiba, Brazil. Working Paper 19, United States Agency for International Development, 1995.

Rideau Transit Group, Confederation line’s light rail vehicle. http://www.ligneconfederationline.ca/, 2013, accessed March 6.

Rodriguez, D. and Targa, F., Value of accessibility to Bogotá’s bus rapid transit system. *Transport Reviews*, 24(5):587–610, 2004.

Rogers, L., O-Bahn Busway. *Transportation Research Record*, 1791:1–5, 2002.

SGS Economics, WestConnex Business Case Review Final Report, City of Sydney, February 2016

SGS Economics, Fensham, P. Exploring a Plan for Growing Sydney, Presentaton toPIA 2015

SNC-Lavalin, Victoria/West Shore Link: Technology and option evaluation. Technical report, Victoria Regional Rapid Transit, 2011.

Stokenberga, A., Does bus rapid transit influence urban land development and property values: A review of the literature. *Transport Reviews*, 34(3):276–296, 2014.

TCRP Eugene-Springfield, Oregon: East West Pilot BRT Lane Transit District. In *Bus Rapid Transit, Volume 1: Case Studies in Bus Rapid Transit*, volume 90. Transportation Research Board, 2002.

Translink, Expo Line Upgrade Strategy, Technical report, South Coast British Columbia Transportation Authority, 2010

Transport for London, London’s Street Family: Theories and Case Studies, 2013

Transport for NSW, CBD and South East Light EIS, Government of NSW, November 2013

Transport for NSW, Sydney CBD to Parramatta Strategic Transport Plan, Government of NSW, September 2015

Transport for NSW, Sydney’s Bus Future, Government of NSW, December 2013

Transports Quebec, Étude de Faisabilité Tramway – Service Rapide Par Bus, 2011

Urban Growth NSW, Draft Parramatta Road Urban Transformation Strategy, Volume 1, September 2015

Urban Growth NSW, Draft Parramatta Road Urban Transformation Strategy, Consultation Outcomes Report, May 2016

Urban Growth NSW, Parramatta Road Urban Transformation Strategy (and supporting documents), Final Version, 9 November 2016

Urban Growth NSW, Parramatta Road Urban Transformation Strategy Precinct Transport Report Reference Report, November 2016

Urban Growth NSW, Parramatta Road Urban Transformation Strategy, Sustainability Implementation Plan, November 2016

URS, City to Gungahlin Transit Corridor: Concept Design Report, April 2012.

URS,

Vecino-Ortiz, A. and Hyder, A. (2015). Road safety effects of bus rapid transit systems: A call for evidence, *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, 92(5):940–846.

Vincent, W., Delmont, E., and Hughes, C. (2012). Energy and environmental impacts of BRT in APEC economies. Report, Breakthrough Technologies Institute.

Vuchic, V. (2007). *Urban Transit Systems and Technology*. Wiley.

Vuchic, V., Stanger, R., and Bruun, E. (2013). Bus rapid transit versus light rail transit: Service quality, economic, environmental and planning aspects. In *Transportation Technologies for Sustainability*, pages 256–291. Springer.

WestConnex, Updated Strategic Business Case, Technical Paper 1 Traffic Report, 2016.

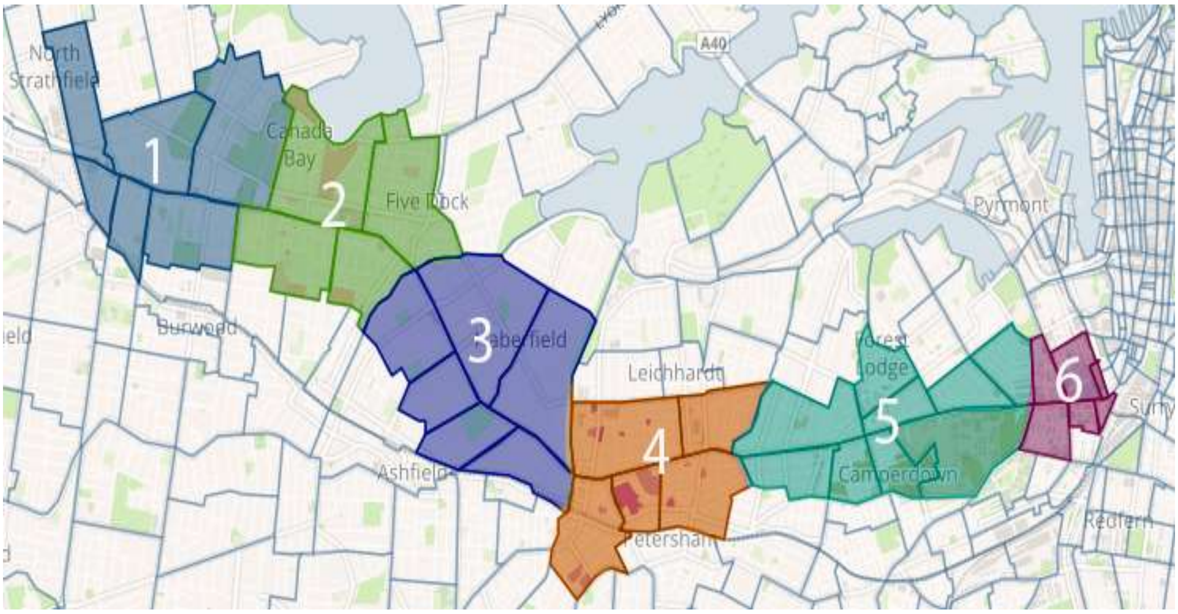
World Bank Group, Lima transport project, Project Performance Assessment Report IBRD-72090, IEG Sustainable Development, 2015.

Xu, H. and Zheng, M., Impact of bus-only lane location on the development and performance of the logic rule-based bus rapid transit signal priority, *Journal of Transportation Engineering*, 138(3):293–314, 2012.

Zhang, M. (2008), Bus versus Rail: Meta-analysis of cost characteristics, carrying capacities, and land use impacts, *Transportation Research Record: Journal of the Transportation Research Board*, 2110:87–95.

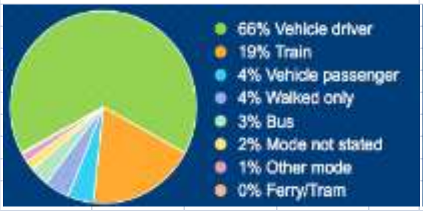
# Appendix A: Corridor Travel Patterns and Demographics

The following is data sourced from Transport for NSW Household Travel Survey and from the 2011 Census provide travel insight into the behaviours of residents and workers across the corridor.




## 1

How do workers commute to their selected employment destination




Origin or place of residence

| % | No. | Origin or place of residence (SA3) |
|---|---|---|
| | 881 | Strathfield - Burwood - Ashfield |
| | 713 | Canada Bay |
| | 233 | Ryde - Hunters Hill |
| | 228 | Canterbury |
| | 176 | Bankstown |
| | 171 | Auburn |
| | 142 | Parramatta |
| | 139 | Merrylands - Guildford |
| | 134 | Sydney Inner City |
| | 115 | Baulkham Hills |
| | 1,946 | Other |

## 2

How do workers commute to their selected employment destination


Origin or place of residence

| % | No. | Origin or place of residence (SA3) |
|---|---|---|
| | 1,003 | Canada Bay |
| | 784 | Strathfield - Burwood - Ashfield |
| | 169 | Canterbury |
| | 139 | Bankstown |
| | 121 | Leichhardt |
| | 120 | Merrylands - Guildford |
| | 111 | Ryde - Hunters Hill |
| | 90 | Auburn |
| | 87 | Parramatta |
| | 85 | Blacktown |
| | 1,012 | Other |

## 3

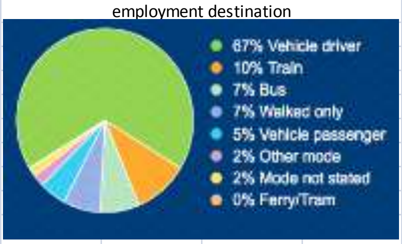
How do workers commute to their selected employment destination


Origin or place of residence

| % | No. | Origin or place of residence (SA3) |
|---|---|---|
| | 1,070 | Strathfield - Burwood - Ashfield |
| | 212 | Canada Bay |
| | 161 | Canterbury |
| | 101 | Bankstown |
| | 89 | Leichhardt |
| | 67 | Blacktown |
| | 62 | Sydney Inner City |
| | 57 | Merrylands - Guildford |
| | 56 | Parramatta |
| | 55 | Ryde - Hunters Hill |
| | 693 | Other |

4

How do workers commute to their selected employment destination




Origin or place of residence

| % | No. | Origin or place of residence (SA3) |
|---|---|---|
| | 922 | Strathfield - Burwood - Ashfield |
| | 724 | Leichhardt |
| | 519 | Marrickville - Sydenham - Petersham |
| | 432 | Canada Bay |
| | 391 | Canterbury |
| | 337 | Sydney Inner City |
| | 212 | Ryde - Hunters Hill |
| | 188 | Bankstown |
| | 181 | Kogarah - Rockdale |
| | 152 | Hurstville |
| | 1,906 | Other |

5

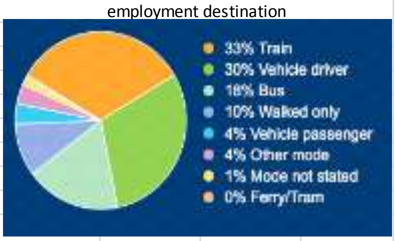
How do workers commute to their selected employment destination


Origin or place of residence

| % | No. | Origin or place of residence (SA3) |
|---|---|---|
| | 3,408 | Sydney Inner City |
| | 1,598 | Strathfield - Burwood - Ashfield |
| | 1,312 | Marrickville - Sydenham - Petersham |
| | 1,296 | Leichhardt |
| | 722 | Canterbury |
| | 641 | Canada Bay |
| | 623 | Eastern Suburbs - South |
| | 614 | Eastern Suburbs - North |
| | 577 | Kogarah - Rockdale |
| | 450 | Hurstville |
| | 6,511 | Other |

6

How do workers commute to their selected employment destination

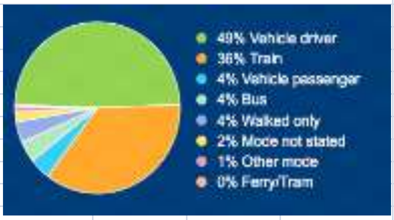



Origin or place of residence

| % | No. | Origin or place of residence (SA3) |
|---|---|---|
| | 2,182 | Sydney Inner City |
| | 790 | Strathfield - Burwood - Ashfield |
| | 744 | Eastern Suburbs - North |
| | 608 | Eastern Suburbs - South |
| | 607 | Marrickville - Sydenham - Petersham |
| | 576 | Leichhardt |
| | 448 | North Sydney - Mosman |
| | 362 | Chatswood - Lane Cove |
| | 354 | Warringah |
| | 347 | Kogarah - Rockdale |
| | 5,515 | Other |

1

How do workers commute from the selected residential area?

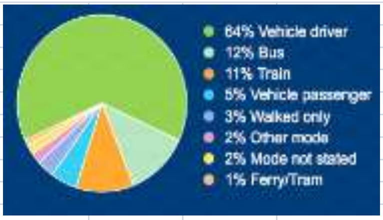



Where do residents in the selected area work?

| % | No. | Destination or place of work (SA3) |
|---|---|---|
| | 1,451 | Sydney Inner City |
| | 735 | Strathfield - Burwood - Ashfield |
| | 675 | Canada Bay |
| | 251 | Auburn |
| | 237 | Ryde - Hunters Hill |
| | 215 | Parramatta |
| | 198 | No fixed place of work |
| | 184 | North Sydney - Mosman |
| | 181 | Chatswood - Lane Cove |
| | 131 | Leichhardt |
| | 1,254 | Other |

2

How do workers commute from the selected residential area?

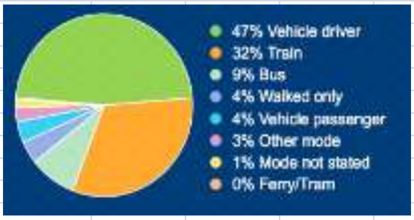



Where do residents in the selected area work?

| % | No. | Destination or place of work (SA3) |
|---|---|---|
| | 1,260 | Sydney Inner City |
| | 708 | Canada Bay |
| | 556 | Strathfield - Burwood - Ashfield |
| | 218 | Leichhardt |
| | 214 | Ryde - Hunters Hill |
| | 186 | No fixed place of work |
| | 157 | Chatswood - Lane Cove |
| | 151 | North Sydney - Mosman |
| | 148 | Auburn |
| | 131 | Parramatta |
| | 877 | Other |

3

How do workers commute from the selected residential area?

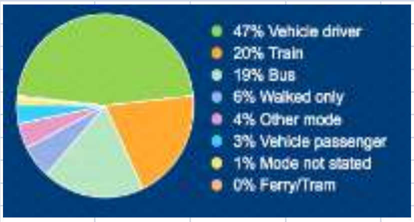



Where do residents in the selected area work?

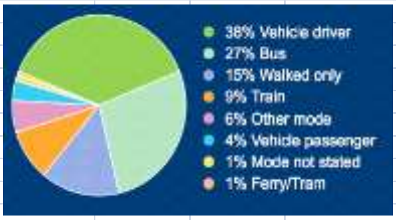
| % | No. | Destination or place of work (SA3) |
|---|---|---|
| | 2,821 | Sydney Inner City |
| | 1,387 | Strathfield - Burwood - Ashfield |
| | 403 | Leichhardt |
| | 347 | Canada Bay |
| | 265 | Ryde - Hunters Hill |
| | 262 | North Sydney - Mosman |
| | 252 | Chatswood - Lane Cove |
| | 213 | No fixed place of work |
| | 198 | Marrickville - Sydenham - Petersham |
| | 195 | Auburn |
| | 1,620 | Other |

| 4 | 5 | 6 |
|---|---|---|
| How do workers commute from the selected residential area? | How do workers commute from the selected residential area? | How do workers commute from the selected residential area? |

**4**




**5**




**6**


Where do residents in the selected area work? (4)

| No. | Destination or place of work (SA3) |
|---|---|
| 2,945 | Sydney Inner City |
| 683 | Leichhardt |
| 417 | Marrickville - Sydenham - Petersham |
| 385 | Strathfield - Burwood - Ashfield |
| 288 | North Sydney - Mosman |
| 231 | Ryde - Hunters Hill |
| 189 | No fixed place of work |
| 187 | Chatswood - Lane Cove |
| 165 | Botany |
| 150 | Parramatta |
| 1,132 | Other |

Where do residents in the selected area work? (5)

| No. | Destination or place of work (SA3) |
|---|---|
| 5,279 | Sydney Inner City |
| 547 | Leichhardt |
| 430 | North Sydney - Mosman |
| 342 | Chatswood - Lane Cove |
| 311 | Ryde - Hunters Hill |
| 273 | Eastern Suburbs - North |
| 258 | Marrickville - Sydenham - Petersham |
| 210 | No fixed place of work |
| 198 | Strathfield - Burwood - Ashfield |
| 187 | Botany |
| 1,339 | Other |

Where do residents in the selected area work? (6)

| No. | Destination or place of work (SA3) |
|---|---|
| 2,399 | Sydney Inner City |
| 194 | North Sydney - Mosman |
| 141 | Eastern Suburbs - North |
| 127 | Chatswood - Lane Cove |
| 101 | Ryde - Hunters Hill |
| 81 | No fixed place of work |
| 77 | Botany |
| 73 | Eastern Suburbs - South |
| 65 | Leichhardt |
| 55 | Strathfield - Burwood - Ashfield |
| 420 | Other |

# Appendix B: Stakeholder Workshop Notes

## Burwood Precinct

Issues that would limit the potential of light rail in this precinct?

- "Squeeze points" - where sections of Parramatta Road need to be shared for turning
- Risk of business/shopkeeper backlash in relation to the perception that adding parking to one lane will create less demand for car usage and therefore limit business. The counter arguments include:
  - The pedestrian environment is enhanced (“We need to make it a living space to support the transformation strategy) and that parking activates the business rather than detracting. King Street was cited as an example.
  - If people are catching light rail they do not need to drive
- It was noted that parking availability - short term and long term parking was a common community concern
- The Burwood centre is a fair way from Parramatta Road ("Nightmare to fathom buses crawling up Burwood road")

What are the opportunities that would increase the potential of light rail in this precinct?

- Use Burwood bus depot as interchange
- Run light rail up part of Burwood beside railway the line
- Terminate light rail at Strathfield because:
  - Potential to link up with Parramatta light rail
  - Easy access to employment generators at each CBD (Sydney and Parramatta) without changing modes
  - Homebush precinct is one of the largest densities in the urban transformation strategy
  - Offers Greater Sydney area another transport option
  - Take load off Olympic Park heavy rail during peak events
- Activating businesses along the tramway
- It would help the case for addressing the overcapacity issue at Rhodes station

Several configuration options were discussed, including:

- A single spur line
  - Pro: good short term option (a longer term option would be to connect to the Parramatta Light Rail line)
  - Con: Only 20m road width
  - Con: Future growth constraints with the light rail service
- The Strathfield loop (Mosely Street and Leicester Avenue)
  - Con: Traffic timing issues which would limit growth potential
- The Burwood loop (Burwood Road and Shaftsbury Road)
  - Pro: Employment benefits
  - Pro: Picks up Westfield shopping centre
  - Pro: Within walking distance of Burwood station
- "The larger loop"
  - Con: Two independent loops would be better option

Other opportunities noted

- Communicate the options for connectivity between Strathfield and Burwood. The context is that Burwood is regional centre. It is important in hierarchy that it is serviced

- City of Canada Bay have developed "priority precinct" – it is a good example of rethinking the vision for an area

Themes from discussion:

- In the long term, the Burwood and Strathfield centres may coalesce (“"Burfield")
- Parking availability - short term vs long term parking is always a high concern for the community

### Kings Bay Precinct

Context for Kings Bay

- Area has a lot of sporting facilities (eg 48 netball courts - 4000-5000 people playing on a Saturday/Sunday). This is a big attractor which means it is busy on weekends with a high parking demand
- A new town centre in Spencer Street
- The importance of the north/south link

What are the opportunities that would increase the potential of light rail in this Precinct?

- Addressing car parking constraints for sporting facilities
- Bus services going north/south on Parramatta road, rather than turning into Parramatta Road as this improves services without massive purchase of new buses
- Improves North/South connectivity
- Provide a Great North Road loop because:
  - It will help address issues related to removing buses from Parramatta Road
  - The old light rail Infrastructure is still there (although it is buried)
  - It has the suitable width required
  - There are amenity opportunities for the area
  - There is potential for ferry link to integrate to light rail (although it was acknowledged that there is a long distance to Parramatta Road
  - It was however also noted that the Great North Road corridor (and old light rail track) is heritage listed
- There are active transport link opportunities, such as:
  - Opportunity for better connectivity to Iron Cove Creek
  - Opportunity to use canal for cycleway as it has sufficient space
  - Green space areas
- Opportunity to supply recycled water to green the corridor
  - Recycled water facility in Canada Bay has the capacity

Themes from discussion:

- Loops, included in plan, even if long term staging will help with community support

### Taveners Hill Precinct

Context for Taverners Hill

- Long and steep gradient in this area (Taveners Hill)
- Paramatta Road is close to heavy rail in this area

What are the opportunities that would increase the potential of light rail in this precinct?

- Have a super stop next to Battle Bridge as well as Flood Street because it has
  - Pro: Suffiient road width
  - Pro: Potential for interchange improvement between this light rail and inner west light rail
  - Pro: Aligned with greenway

    - Con: Need to consider gradient issues and technology to address it
- Need to be looking at place-making in this section because it will be a higher density residential area in future. It is also a great transport hub area - "it has everything"

Themes from discussion:

- Classification of stops is important: Technology is now available that can be smarter with regards to timing and stop frequency (eg: only stop if tap on "whistle stop"). This supports more stops without time penalty

## Leichhardt Precinct

Context for Leichhardt

- There are railway lines under Norton Street
- Heavy buses and little pedestrian space in the area

Issues that would limit the potential of light rail in this precinct?

- Heritage constraints - narrow road and buildings cannot be redeveloped (“hardest area”). Limited uplift opportunity

What are the opportunities that would increase the potential of light rail in this precinct?

- Light rail potential to reactivate this area as it is a higher order/higher standard form of transport
- Leverage old route (railway lines under Norton Street)
- Place stop (with staggered platforms) at Crystal and Norton with combined through and right turn as there is sufficient space
- During peak times, straight through on kerbside and straight and right on the centre lane
- Potential to leverage previous commercial retail studies of Norton/PR and urban design/heritage study
    - Light rail enhances the story told in this work
- Opportunity for the forum to be a great place. For example, enhancing pedestrian environment in Balmain road
    - Note: this requires grade change in forum building
- Light rail has more predictability that buses (buses can pass by during peak periods when full)
- Ease crossing time for north/south vehicular (bus) movement via optimising traffic light timing/movements
- Feeder buses northbound on Balmain Road and southbound on Norton Street

Themes from discussion:

- "Getting people into these places without their cars"
- Placemaking is important in this area as there is negative amenity in this area (huge opportunity)

## Camperdown Precinct

Context for Camperdown

- Some urban transformation has taken place here
- Councils position, along with Uni of Sydney and RPA, want to retain employment uses and develop a biotech hub in the area
- Camperdown stops with link with the city's active transport corridor

Issues that would limit the potential of light rail in this precinct?

- Footbridge potentially has interfacing issues with WestConnex portal. This impacts access to the university as the footbridge is the best access to university
- Different gauge on Inner West line. While this will make things messy, it was noted that it does not preclude another rail within the wider gauge in the longer term
- Storage of non-running rolling stock as in the short term the service will not be running 24 hours

What are the opportunities that would increase the potential of light rail in this precinct?

- Use Roselle rail yards for storage of non-rolling stock as it:
  - Is currently or planned to be used for maintenance and cleaning of rolling stock
  - Con: Residential amenity impacts
  - Con: Lack of space for storage
  - Con: Designated for development by Bays precinct
- Use racecourse for non-running stock storage
- Connect into CBD South East line
- Train Stop should straddle Missenden and Lyons roads as this will pick up the hospital (RPA)
- Potential to pick up Sydney University (the university is a big loading/unloading point on the corridor)
- Potential stop at footbridge as this is where most students get on and off.
  - However it was noted that the footbridge potentially has interfacing issues with WestConnex portal
- Opportunities for value uplift because it enhances initiatives like the biotech hub. This is because light rail will have a higher profile and attract investment. It provides investor confidence and provides an enticing environment for a hub. “This will attract serious foreign investment”

### Non-precinct topics: funding models

Options discussed:

- Local Government VPA
  - Pro: To fund this project, each local government area needs to sells enough airspace to fund the loop
  - Con: Takes a lot of council resources
  - Con: It is voluntary
  - Con: Often leads to undesirable outcomes (not the best community outcome: “selling your soul”). It was noted that if you have clear objectives, negotiation is easier
- State government special infrastructure contribution levy for Parramatta Road. This is done per new dwelling to pay for infrastructure
  - Con: Does not apply to existing zoned land
  - Con: 50% already allocated to schools, and other allocations have been assigned. The implication is that action would need to happen immediately
  - Con: Only applies to identified precincts
- Standalone levy on all properties in the corridor (eg Add levy to each dwelling as part of general rates)
  - Pro: Everybody benefits
  - Con: Will cause ratepayer issue
  - Con: Affects renters because landowners pass on the cost
- A State government, special infrastructure levy was suggested as the best option because of the region wide approach to funding

Themes from discussion

- There needs to be a region-wide funding approach, otherwise investment may be distorted
- By putting in light rail, we are freeing up several hundred buses for other areas ("We are increasing the reach of the public transport system without additional purchase of buses")
    - Cost of $150-200k per bus
- Economy of scale in maintenance by maintaining compatibility with CBD South east system

### Non-precinct topics: Cycleways

- Study needs to demonstrate consideration for cycling
- Potential for a cycling network to weave and cross key points - avoiding Parramatta Road
- Light rail is more predictable for cyclists but from a safety point of view, it is harder for light rail to brake in emergencies (eg cyclist cutting across)
- Opportunity to integrate with major cycle route on Queens Road
- Commuter cycle paths should be separated away from light rail route but we should not preclude cycling from Parramatta Road (speed limits - designed to 30km and commensurate to cycling level of critical mass)

### Other non-precinct topics

- Potentially address whether light rail could be supplanted by newer transport technology
    - "Every mode of transport eventually gets outmoded" - The important thing is to preserve the corridor
- Adaptive re-use of carparks
- Catering for park and ride services
- Addressing perceived issue of constructability which was cited as an issue last time light rail was looked at. This time, with the other projects, timing is beneficial. - "Now is the time"
- Critical timing to lobby in relation to co-ordination with commissioning of WestConnex stage 1 portal
- Opportunity (as part of an asset management story) to sell timing benefits as part of provisioning light rail

### Summary of themes

- Move Parramatta Road from being a place for cars to a place for people
- "Now is the time"
- Needs to be a region-wide funding approach
- The important thing is to preserve the corridor
- "Getting people into these places without their cars"
- Classification of stops is important
- Loops, included in plan, even if long term staging will help with community support
- Parking availability - short term vs long term parking
- "If we get a link between Burwood and Strathfield we are talking about a genuine network"
- Strathfield Station as an intermodal node and can provide linkage to the CBD and broader region
- A network is required and this needs to include the option for linking of Olympic Park, Wentworth Point, Rhodes and Concord Hospital.

## **Appendix C:** WestConnex Interchanges


**Concord Road**


**Parramatta Road Interchange**


## Haberfield Interchange


## Homebush Bay Drive Interchange

# WestConnex

Australian Government
BUILDING OUR FUTURE

NSW
MAKING IT HAPPEN



17 November 2016

Dear resident

Work is underway on WestConnex, which involves widening and extending the M4 motorway, duplicating the M5 motorway and joining the M4 and M5 to create a free-flowing motorway network.

Planning continues for the proposed M4-M5 Link – the third stage of the WestConnex project linking the M4 at Haberfield to the M5 at St Peters via underground tunnels. For more information on the M4-M5 Link, visit westconnex.com.au/M4-M5Link.

In response to your feedback at our first round of community consultation for M4-M5 Link in July and August this year, a number of significant changes have been made to the early design, including the removal of the exit and entry ramps at Camperdown.

**WestConnex would like to correct some misinformation about the potential Camperdown mid-tunnel construction site:**

- The midpoint tunnel site at Camperdown will require part of the 'triangle area' bordered by Parramatta Road, Pyrmont Bridge Road and Mallet Street in Camperdown
- We are not taking any green space for this construction site. There is no existing green space in this 'triangle area'
- We are not using the Kennards site on Booth Street
- Construction traffic will not use Booth Street
- Parramatta Road will be our key traffic route. Traffic will enter the site via Parramatta Road and exit near the corner of Parramatta Road and Pyrmont Bridge Road
- Surface construction hours will be standard construction hours (consistent with Stage 1 and Stage 2 of WestConnex) which are 7am to 6pm Monday to Friday and 8am to 1pm on Saturdays
- There will be no compulsory residential acquisitions for this site
- There will be no permanent tunnel support facilities or ventilation outlet built at this site and all mid-tunnel construction facilities will be removed.

You can continue to provide feedback throughout the M4-M5 Link design process. This feedback will be incorporated into the design in readiness for another round of community consultation in January 2017. We know people live busy lives and may not be able to attend public consultation meetings. We are happy to come to your home, your local neighbourhood or your community group to discuss the M4-M5 Link project in more detail. Please contact us on the details below if you would like to arrange a meeting.

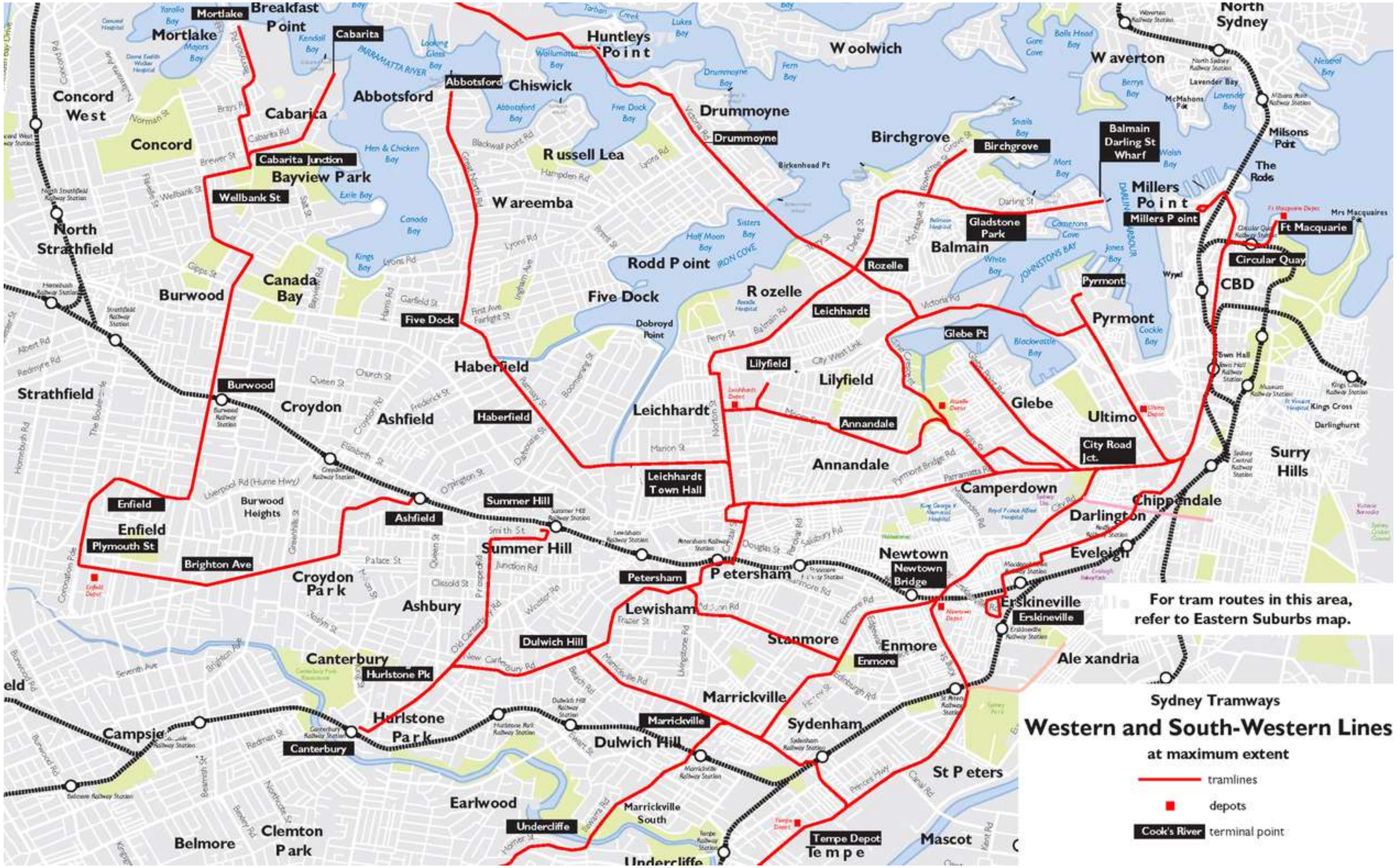
Following the feedback from the January – March 2017 consultation, it is expected that an Environmental Impact Statement (EIS) will be prepared in mid-2017. This will be subject to another round of consultation which will be included in a report to Department of Planning and Environment for its consideration as part of the planning process.

If you would like further information, please call 1800 660 248 and ask to speak with a member of the M4-M5 Link project team or email info@westconnex.com.au.

**ABOUT WESTCONNEX**
**WestConnex is part of a broader transport plan for Sydney which includes improved public transport, such as Sydney Metro and light rail, as well as better, more reliable motorway solutions. More than two-thirds of WestConnex will be built underground. Once complete, motorists will be able to avoid up to 52 sets of traffic lights and enjoy significant travel time savings.**

For more information
info@westconnex.com.au
1800 660 248
westconnex.com.au

# **Appendix D:** Historic Tram Routes (https://en.wikipedia.org/wiki/Trams_in_Sydney accessed 1/12/2016)



## **Appendix E:** Pair-wise Comparison

# Pairwise Comparison Matrix

| ***=Much*** More Important | ***=More*** Important | The ***=Same*** | ***=Less*** Important | ***=MuchLess*** Important |
|---|---|---|---|---|
| 9 | 3 | 1 | 0.333 | 0.111 |

**<u>If all are equal</u>**

| ***Criteria*** | | **function as arteri** | **mode shift** | **economic** | **social** | **cost** | **timilness** | **0** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **X** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | Total | % |
| **function as arterial** | **1** | **X** | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 5.00 | 17 |
| **mode shift** | **2** | 1.00 | **X** | 1.00 | 1.00 | 1.00 | 1.00 | | 5.00 | 17 |
| **economic** | **3** | 1.00 | 1.00 | **X** | 1.00 | 1.00 | 1.00 | | 5.00 | 17 |
| **social** | **4** | 1.00 | 1.00 | 1.00 | **X** | 1.00 | 1.00 | | 5.00 | 17 |
| **cost** | **5** | 1.00 | 1.00 | 1.00 | 1.00 | **X** | 1.00 | | 5.00 | 17 |
| **timilness** | **6** | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | **X** | | 5.00 | 17 |
| **0** | **7** | | | | | | | **X** | 0.00 | 0 |
| | | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 0.00 | 30.00 | 100 |
| | | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 0.0 | 100 | 30.00 |

## Multi Criteria Assessment

The public transport options for the Parramatta Road corridor were evaluated using Multi-Criteria Assessment (MCA). The results of the evaluation, including a discussion on the results of sensitivity tests for the evaluation, are presented below.

## Evaluation Criteria

Evaluation criteria were formulated so that a balanced evaluation of the proposed public transport options for the corridor could be achieved. These were developed during stakeholder workshops and refined by the study team. The categories that were chosen for the evaluation criteria reflect the place and movement paradigm but also included the element of constructability.

The number of criterion that have been chosen are balanced so that the number of criterion within the broader categories of transport and cost and engineering criteria are balanced with the natural and social environment criteria sets.
The table below rates each the transport options on a 5 point scale where 5 = Excellent, 4 = Very good, 3 = Good, 2 = Fair and 1 = Poor.

The scores given are based on workshops and meetings with stakeholders and staff and are in part an interpretation of the findings by the Study team.

| **Criteria** | | | |
|---|---|---|---|
| | **BRT** | **T** | **LRT** |
| **Movement** | | | |
| Moving people from place to place efficiently | 3 | 4 | 5 |
| Providing a range and interconnection of transport modes | 5 | 5 | 3 |
| Higher passenger capacity per lane per hour | 2 | 4 | 5 |
| Adaptability and agility (avoids breakdowns) | 5 | 4 | 1 |
| Access for utilities and services | 5 | 5 | 1 |
| Access for emergency response and deliveries | 5 | 5 | 5 |
| Safety providing a safe environment for movement in all modes | 2 | 5 | 5 |
| Provides for north south as well as east west movement | 3 | 4 | 2 |
| Improved connectivity between places | 2 | 5 | 3 |
| Accommodates and encourages high level of pedestrian activity | 2 | 5 | 5 |
| Allows for short term parking and loading | 1* | 5 | 5 |
| Accommodates cycling infrastructure | 1* | 5 | 5 |
| Provides places for car share facilities | 5 | 5 | 5 |
| Supports intended road function -arterial | 3 | 4 | 3 |
| Corridor preservation for 5 light rail | 1 | 5 | 5 |
| Future proofing and preserving future opportunities | 3 | 5 | 1 |
| Mode and service integration | 1 | 5 | 3 |
| Traffic management | 1 | 5 | 5 |
| Services the needs of adjoining land use | 4 | 5 | 3 |
| Meets future transport demand | 2 | 4 | 5 |
| **Score** | **56** | **94** | **75** |
| **Place** | | | |
| Suited to current conditions and transitional aspirations | 2 | 5 | 5 |
| Improves social connectivity | 2 | 5 | 2 |
| Strengthens place identity | 2 | 5 | 5 |
| Limits impacts of construction on community and business | 5 | 5 | 2 |
| Reduces emissions | 1 | 5 | 5 |

| | | | |
|---|---|---|---|
| Reduces noise | 1 | 5 | 4 |
| Enables greening the corridor | 2 | 5 | 5 |
| Reduces heat island impacts | 1 | 4 | 5 |
| Caters for increased housing supply | 2 | 5 | 5 |
| Support increases in local employment | 2 | 5 | 5 |
| Increases business activity and viability | 2 | 5 | 5 |
| Accommodates and encourages high level of pedestrian activity | 2 | 5 | 5 |
| Allows for short term parking and loading | 2 | 5 | 5 |
| Assist to create high amenity of the public realm | 1 | 5 | 3 |
| Suited to customer preference and convenience | 1 | 5 | 5 |
| Heritage conservation | 5 | 5 | 4 |
| Adjoining land use | 3 | 5 | 3 |
| **Score** | **36** | **84** | **73** |
| **Constructability** | | | |
| Suited to the physical environment | 5 | 5 | 2 |
| Meets and identified need | 2 | 5 | 5 |
| Fit – road width and gradient | 5 | 5 | 3 |
| Network integration | 4 | 5 | 3 |
| Safety | 2 | 4 | 4 |
| Cost of implementation – route construction and vehicles | 5 | 3 | 1 |
| Reduces need for services upgrade and relocation | 5 | 3 | 1 |
| Resilience | 5 | 4 | 1 |
| Timeliness – lead time to operation | 5 | 4 | 1 |
| Day one implementation | 5 | 4 | 1 |
| Flexibility and futureproof, | 3 | 4 | 2 |
| Program of works integrated with other construction projects | 5 | 5 | 1 |
| Progressive implementation | 5 | 5 | 1 |
| Suited to staged construction | 5 | 5 | 1 |
| Construction impacts and duration | 5 | 4 | 1 |
| Politically acceptable | 3 | 4 | 5 |
| Demonstrates commitment to quality public infrastructure | 1 | 5 | 5 |
| Broadly supported by community and stakeholders | 1 | 5 | 5 |
| **Score** | **71** | **79** | **43** |
| **Total Score** | **163** | **257** | **191** |

**BRT rates low based on kerb running. If this score is increased there is no change significant change to the outcome.*

## Sensitivity Testing

The first stage of the MCA is a pair-wise comparison of criteria. This generates a weighting for each criterion. The pair-wise comparison technique compares each of the criteria against each other sequentially. For example, criterion A is compared against criterion B in terms of which criterion is “preferred” over the other one. A ’value’ for this level of preference is then assigned to this comparison.

The range of values that have been used are 9 = major preference; 3 = medium preference; and 1 = same, 0.333 = less important, 0.111 = much less important. This process then results in a pair-wise matrix **Appendix E**.

The pair-wise process then generates a series of ’weightings’ for the criterion.

The resultant criterion were each grouped under one or other of the following categories and the weighting are presented below.

| Goals, desired criteria, function and features | Raw Score | Pairwise Weight |
|---|---|---|
| **Movement** | **225** | **14%** |
| Supports mode shift | | 5 |
| Allows continued arterial road function | | 9 |
| **Place** | **193** | **18%** |
| Achieves urban transformation economic goals | | 9 |
| Achieves urban transformation social objectives | | 9 |
| **Constructability** | **193** | **68%** |
| Affordable | | 27 |
| Timeliness | | 41 |
| **Total** | **611** | |

The percentage weightings nominated below are the 'baseline' score and the weighting after pairwise comparison. This shows that although movement was the most influential criteria originally in the choosing the preferred mode this changed when a pairwise comparison was undertaken and constructability was thought more important. Because the GET had scored higher against all categories the changed weighting does affect the result and the GETV is still the preferred mode. However, it did impact the second choice where light rail had been preferred over BRT and this was reversed as cost and ease of implementation became the most influential criteria influencing selection.

**PARRAMATTA ROAD**
**LIGHT RAIL OPPORTUNITIES STUDY**

# ANNEXURE
# Comparison:
# Rapid Bus Service & Guided Electric Transit System


Sydney can assume a leadership role in public transport *and* ***'put NSW at the forefront of adopting emerging transport technologies, unlock value in the system and customise and personalise transport services for customers across the state'.*** (TfNSW 2016)

**Bodhi Alliance Pty Ltd**
**EDAB Consulting Pty Ltd**

**Version:** 18/02/2017

# CONTENTS

# SUMMARY

As an approval condition of WestConnex (Stage 1) two lanes of dedicated transit are to be provided along Parramatta Road. To assist Inner West and City of Canada Bay Councils (**Councils**) to better participate in the decision-making relating to the best use of this dedicated transit corridor a Study was commissioned by Councils in 2016. The focus of the Study was to evaluate the potential for Light Rail along Parramatta Road to improve public transport and to act as a catalyst for future development. This Study determined that Light Rail was not a preferred option for this corridor in the short term.

The Study did though identify that a more advanced form of transit, termed Guided Electric Transit System (GETS), was worthy of further more detailed investigation as this would better achieve the urban transformation objectives of the Parramatta Road Corridor Urban Transformation PRCUT Strategy and would be more affordable and easily implementable. The GETS is based on a suite of proven and rapidly developing technologies which, in various forms, are currently being successfully and increasingly used overseas. The GETS is a version of rapid transit vehicle providing similar performance and amenity to light rail at significantly lower cost and with greater opportunities for network integration and staged expansion. The key difference is that it has rubber tyres and therefore can run on an existing road pavement. Emergent battery and charging technologies provide on-board electric fast charge electric capability that does not require the cost or visual intrusion of overhead wires, or continuous in-ground induction rails.

The Study also concluded that the GETS is preferable to the Rapid Bus Service (RBS) as proposed in the PRCUT Strategy. The RBS whilst having some merit has significant limitations. It does not have the appeal or capacity to attract or accommodate travel demand to the extent necessary to achieve the desired urban transformation.

The Study provided a high-level identification and appraisal of options as distinct from a detailed feasibility investigation. This was consistent with the prime purpose of the Study being to provide an informed basis for the Councils to engage proactively and productively, with the NSW Government, in subsequent detailed investigation of enhanced public transport in the corridor. In that regard the NSW Government in conjunction with release of the PRCUT Strategy and associated Implementation Plan has identified the *Burwood – Sydney CBD On Road Transit (BSORT)* project.

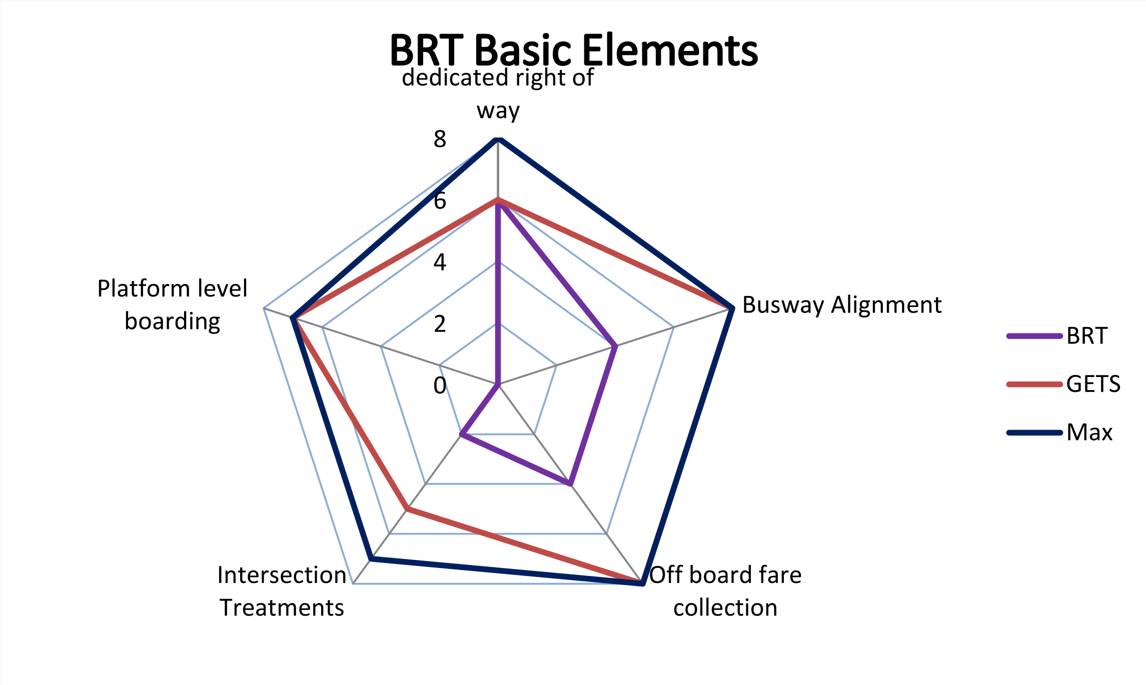
Subsequently, the Councils, consistent with seeking to be well-informed and so productive participants in future investigations such as the BSORT project, requested a finer-grained comparison of the RBS and the GETS. This is provided in this Annexure to the Study Report.

In particular the Council sought information on various aspects of the two options. It was determined that there was little difference between the GETS and RBS on many of these aspects. However, overall the GETS was the superior option. It is noted that at this stage the proposal of the GETS and RBS are conceptual only and more detailed investigations are required to improve the accuracy of the comparison. This Annexure (as with the initial Study) relies on recent research and industry experience in various jurisdictions throughout the world. This approach has limitations and further reinforces the view that more detailed investigation is required. This is most appropriately addressed through the BSORT.

An additional comparison of the RBS and GETS options was undertaken utilising the Institute for Transportation and Development Policy (ITDP) International Standard and associated rating Scorecard for rapid transit public transport systems. It is noted that the term Bus Rapid Transit is used for the Standard and Scorecard and that it has broad application such that it embraces the RBS and GETS options. Therefore use of the Standard and Scorecard was determined to be highly relevant especially given there is a strong link between rapid transit and urban transformation in terms of increases to property values and economic development in, along and adjacent to the corridor of operation (as identified in an international study for Infrastructure Australia in 2013).

Bus Rapid Transit as defined in the ITDP Standard is a road-based rapid transit system that can achieve high capacity, speed, and service quality at relatively low cost by combining segregated lanes that are typically median aligned with off-board fare collection, level boarding, vehicle priority at intersections, and other quality-of-service elements (such as information technology and strong branding). The ITDP Standard is applicable to the RBS (of the PRCUT Strategy) and the GETS identified in the Study.

The additional ITDP based comparison served to identify that the RBS as currently proposed by the NSW Government does not meet the basic requirements for a Bus Rapid Transit system as compared to the GETS which is rated as being of an advanced level.




Of the 30 scoring elements included in the ITDP Standard Scorecard the RBS and the GETS differed in 11 elements. However, the scoring for those 11 elements resulted in the GETS being rated as a *Gold Standard System* and the RBS being not eligible for certification. The RBS would need to include 2 of the following elements: centre running; signal priority; and/or platform-level boarding to qualify for certification. It is noted that the ultimate form of RBS proposed for the Parramatta Road Corridor may differ slightly from that assumed in this comparison. Nonetheless the comparison conducted does provide insight into the potential impacts of various options and associated elements of the design, construction and operation of a public transport system along Parramatta Road.

In that regard, this comparison incorporates consideration of the rationale implicit in the proposed RBS and determined it to be a significant departure from that required to effect the urban transformation of the Parramatta Road Corridor. That is, the form and timing of implementation of an improved public transport system is vital to achieve the desired transformation of the Parramatta Road Corridor. There is a need at the earliest opportunity to 'claim and preserve' from 'Day One' the Parramatta Road Corridor for enhanced provision of public transport - in-synch with the delivery program and consistent with the prime purpose of WestConnex. This would serve to preclude the leakage of private commuter car use back onto Parramatta Road (in response to tolls) and the inevitable latent traffic demand. The GETS offers (amongst many advantages compared to the proposed RBS and Light Rail) a readily manageable implementation timeline – 'immediate' and scalable.

It is understood that investigation of improved public transport along the Parramatta Road Corridor is currently underway, presumably in accord with the BSORT project and so will include consideration of RBS or alternative solution. It is strongly recommended that GETS be included as an alternative solution. This would provide the basis for a partnered approach (involving Councils together with NSW Government and its Agencies). It would ensure transparency of decision-making and promote selection of a public transport system of form and timing appropriate to realisation of the vision for Parramatta Road as a vibrant corridor. This would be an optimum outcome for the community and business. However, it is imperative that both levels of government jointly engage in subsequent detailed investigations at the earliest opportunity.

The Government of New South Wales has the stated aim ***to put NSW at the forefront of adopting emerging transport technologies, unlock value in the system and customise and personalise transport services for customers across the state.*** (*Future Transport Technology Roadmap,*TFNSW 2016)

An opportunity has been identified whereby **Sydney can assume a leadership role in public transport**. By progressing beyond the well-proven and well-accepted advantages of light rail and harnessing proven and rapidly developing technologies to provide a rapid transit system along key transport corridors. The greater Sydney urban region offers great potential for such a system. This would best serve the commitment to improving public transport to enable urban transformation – making a great city more vibrant and sustainable. This can be achieved at much lesser cost and be implemented quicker than light rail. It also offers greater flexibility in terms of extending beyond the key transport corridors so creating a truly integrated public transport network. It has been termed 'Guided Electric Transit System' (GETS) –adopted for convenience of reference. It is best considered as a solution that promotes the concept of 'rapid transit corridors' using best available and most cost-effective technologies**.**

# 1. INTRODUCTION

In 2016 a Study to investigate the potential for Light Rail to be used on Parramatta Road was commissioned by the Inner West Council. The scope of the Study focussed on the Parramatta Road Corridor from Strathfield to the Sydney CBD and the context of relevant policy and planning initiatives. The scope was subsequently broadened to include the jurisdiction and associated interests of the City of Canada Bay Council.

The prime purpose of the Study was to enable productive engagement of the Councils with the NSW Government and its Agencies to progress the commitment to revamp and revitalise Parramatta Road as a 'vibrant urban corridor'[27]. The Study also considered other interrelated initiatives such as the proposed Parramatta to Strathfield Light Rail. That is, the Study was essentially a public transport '<u>position-paper</u>' to provide an informed basis for the Councils to participate in the decision-making process on matters of paramount importance to their respective constituents – current and future generations. The Study was <u>not</u> a detailed feasibility investigation; rather it set the parameters for such further work.

The Study was completed and duly reviewed by Council Officers in mid-December 2016. In essence the Study concluded that whilst Light Rail would bring benefits to the corridor it was not a preferred option[28]. Rather a Guided Electric Transit System (GETS) offered a superior solution. Whilst the NSW Government has demonstrated strong interest and commitment to Light Rail it has through its Agencies indicated a preference for a Rapid Bus Service (RBS) along Parramatta Road[29]. However, it is appears unlikely that a GETS was included in the options considered as they are not yet commonly understood by the general stakeholders and community in Australia. Consequently, the Councils have requested further research beyond the initial Study to <u>analyse the proposed RBS and GETS options by way of comparison of their key characteristics</u>.

This further research is presented in this Annexure to the original Study Report.

[27] At page 9: http://www.aeol.com.au/databases/news/16/11/nswgov_parramatta_road_urban_corridor.html

[28] The NSW Government through its Agencies (primarily Growth NSW & Transport for NSW) advocate a Rapid Bus Service (inappropriately referring to it at times as a Bus Rapid Transit system) as being a preferred option with the possibility of Light Rail being considered in the longer term (say 10+ years).

[29] ibid

# 2. CONTEXT

The context for the initial Study and in turn for this further research is primarily the *Parramatta Road Corridor Urban Transformation (PRCUT) Strategy*. This was issued in final form in November 2016[30]. In conjunction with the PRCUT Strategy an Implementation Plan (2016-2023) was also issued. In the accompanying NSW Government announcement public transport was highlighted:

> *To help implement the strategy and ensure change and growth occurs in a staged and coordinated manner, a supporting Implementation Plan identifies the priority areas for rezoning and identifies the infrastructure required to support land use change. The Implementation Plan includes:*
>
> - *the provision for at least two dedicated public transport lanes on Parramatta Road*
> - *a commitment to investigate a rapid bus service or an alternative public transport solution.*

The Implementation Plan itself states:

> *Public transport is a critical component of the transformation of Parramatta Road. Without improvements in public transport, the growth envisaged for many parts of the Corridor could not be supported. A range of strategic public transport initiatives is planned for Parramatta Road. They will be delivered incrementally in alignment with existing opportunities, other related projects, funding commitments and government approvals processes. Key initiatives include:*
>
> - *the stepped delivery of the Burwood – Sydney CBD On Road Transit (BSORT) project commencing in 2019–20, in line with the opening of WestConnex M4 East*
> - *resolution of the interface between the BSORT project and the Sydney CBD and South East Light Rail project*
> - *Sydney CBD to Parramatta Strategic Transport Plan*
> - *completion and approval of the Business Case for the Parramatta Light Rail*
> - *completion and approval of the Business Case for the Western Sydney Rail Needs Study.*

And so it is quite apparent that the importance of public transport to effect the transformation of Parramatta Road is well recognised by the NSW Government and its Agencies. Also it would seem that the *commitment to investigate a rapid bus service or an alternative public transport solution* is to be undertaken as the *Burwood – Sydney CBD On Road Transit (BSORT)* project. The GETS option fits within the scope of on-road transit.

Of note *Burwood to CBD via Parramatta Road* has previously been identified in the Sydney Future Rapid Bus Routes[31]. There are also strong indications that the NSW Government through its Agencies has firmed to the view that in the short term a Rapid Bus Service (RBS) is the preferred option for Parramatta Road (as distinct from *an alternative public transport solution*).

Through discussions with Transport for NSW a Business Case (in final stages of preparation) was alluded to as being relevant to this investigation. Also that the GET system was not yet well understood nor being given serious consideration. The reason given for only passing and oblique mention of the Business case was essentially it was a work in progress subject to 'Cabinet in Confidence' restriction. In the absence of other information being available it has been necessary to assume that this is the case and so this model has

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30 http://www.aeol.com.au/databases/news/16/11/nswgov_parramatta_road_urban_corridor.html
31 http://www.transport.nsw.gov.au/projects/bus-priority-program

formed the basis for the comparison with the GETS as identified in the initial Study for the Councils.

# 3. CONSIDERATIONS

The following table outlines the physical and operational configuration of both the RBS and the GETS. It is noted that the assumptions of the RBS have been informed by the PRCUT Strategy, accompanying Implementation Plan Toolkit documents and engagement with Transport for NSW (TfNSW). It is understood that TfNSW are undertaking further investigations into the proposed RBS. It is presumed that the opportunity still exists for that investigation to also include alternative solutions (such as GETS) consistent with the commitment by the NSW Government.

| **Configuration of the RBS**<br>**(as anticipated for Parramatta Road)** | **Configuration of the GETS** |
|---|---|
| <br>• Branded standard single diesel buses<br>• Spacing of stops – assumed as currently exist<br>• Superstops will have seating and some with shelters and landscaping<br>• Kerbside running in painted pavement<br>• Dedicated lanes at peak. It should be noted on the information available the implementation of the RBS is to be staged over a period of 10years or more.<br>• Accessibility will be as per currently exists (wheelchair accessible buses that squat and have a driver operated ramp)<br>• On-board fare validation (consideration is being given to changing the fare validation system with a more advanced contactless system)<br>• No signal priority<br>• Front door boarding<br>• Squatting bus with ramp for disability access<br>• Scalable with ability to add additional buses including higher capacity buses to system<br>• Real time passenger information on vehicle and at stations is envisaged in the longer term as stated in the Sydney Bus Future. | <br>• Branded and highly recognisable and high customer appeal<br>• Station spacing aligned to needs of PRCUTS no more than 800m<br>• Superstop stations with -weather protection and bicycle facilities – bike share and storage<br>• Dedicated lanes (painted pavement)<br>• Centre running<br>• Off board fare validation<br>• Signal priority<br>• Multiple door boarding<br>• Full disability accessible low floor small gap between platform and vehicle, audible travel advice on and offboard<br>• Electric or hybrid electric vehicle proven technology<br>• Various sized vehicles including 24m vehicle (3 standard buses) = less vehicles to move the same number of people at peak.<br>• Scalable can increase system capacity to cater for demand<br>• Low noise and pollution<br>• Real time passenger information on vehicle and at stations<br>• Higher capacity vehicles and dedicated lanes provides additional opportunities to space arrivals more evenly apart and avoid clogging/bunching as currently occurring with existing buses. |

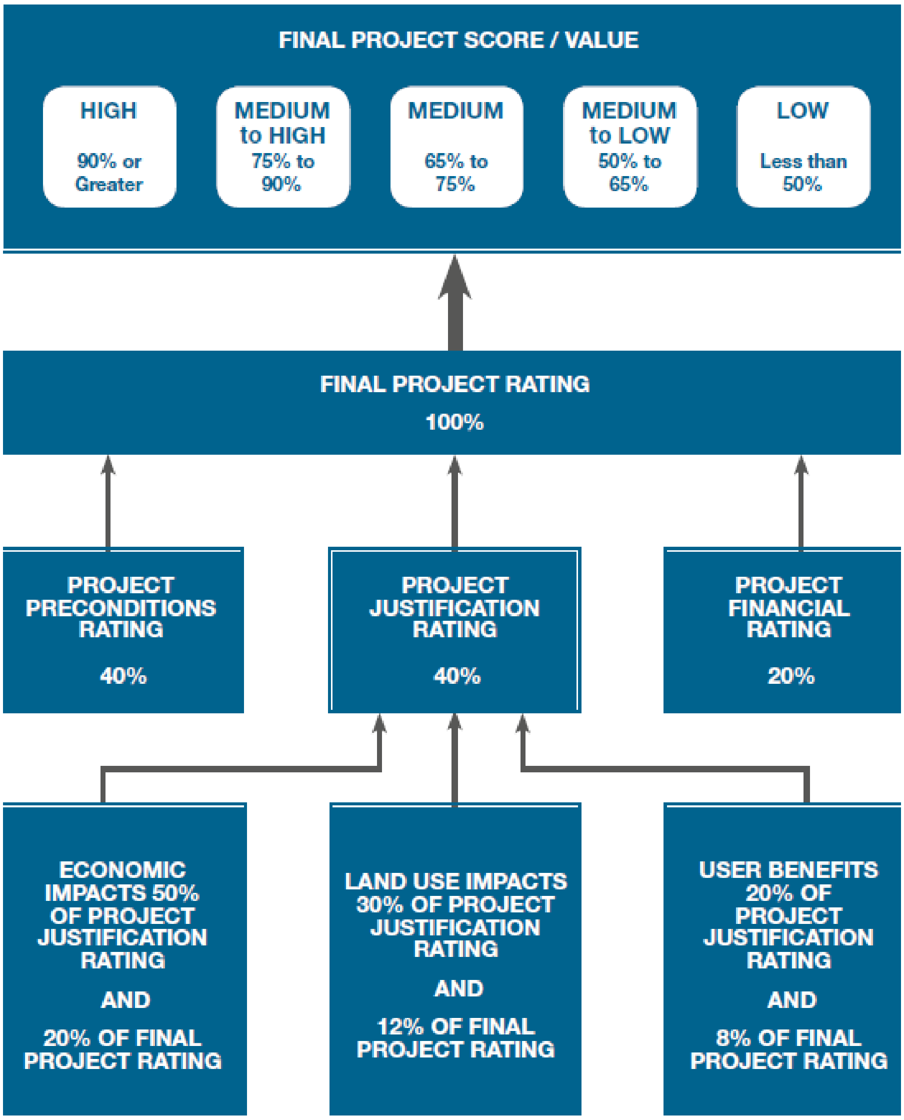
| ADDITIONAL COMMENTS | |
|---|---|
| This is largely a *Business as Usual* proposal with some network improvement, providing a more reliable higher frequency of service (the study team were advised this will be through the platooning of buses during peak periods) and branding will provide greater legibility.<br><br>The New Parramatta Road Infrastructure Schedule allocates approximately $132m for bus priority improvements to be undertaken between Burwood and Camperdown precincts in the short term (2016-2023). Of this allocation 50% is to be payable through possible levies on new developments with the rest by TfNSW | The GETS represents a new combination of existing technologies and will require stakeholder and community education, as well as design certification.<br><br>The European double articulated vehicles may not be Australian Design Rules (ADR) compliant and may need to be tested within Australia. The Parramatta Road corridor is well suited to a pilot scheme that would enable implementation of this system and which could be considered an affordable rubber tyred tram without an overhead power supply.<br><br>The issue of fit for centre running vehicles will also need to be addressed through detailed design of stations.<br><br>Service frequency and higher capacity vehicles should cater for demand and as with the light rail passing lanes are not necessarily required. However if needed due to congestion or breakdown passing can be accommodated utilising the mixed used adjacent lane. Making this a more suitable option than buses with passing lanes.<br><br>The guided system that provides lane assistance, docking accuracy, and incident avoidance will also allow the vehicle to run in a narrower corridor than conventional buses *All assist and automation technologies help to reduce frequency and severity of crashes and collisions and reduced running and station dwell times.*[32] |

[32] Characteristics of Rapid Bus Transit for Decision-Making, United States Department of Transportation, 2004

# 4. BASIS OF COMPARISON

## Australian Rapid Transit Assessment Guidelines (ARTAG)

A Model referred to as the Australian Rapid Transit Assessment Guidelines (ARTAG) was devised by the Bus Industry Confederation (BIC) of Australia and presented in in the Report *Rapid Transit Investing in Australia's Transport Future* (2014) prepared for Infrastructure Australia. The Model shown in simplified schematic form below.




The ARTAG criteria identify the economic, population, housing, environmental and social preconditions for developing Rapid Transit. In applying these criteria to the determination of 'when' to build Rapid Transit it is possible for governments to make a parallel determination of 'what' form of Rapid Transit system and design best suits the specific needs of a proposed corridor and fit within a broader policy framework related to improving public transport in a region.

The Model was developed to provide an assessment tool for comparative evaluation of rapid transit both road and rail based. The assessment model sought to answer 3 questions for Governments investing in transport infrastructure:

1. Is the project sound in the context of public transport investment and land use planning across an entire network?
2. Does the project deliver economic, land use and user benefits to justify its cost?
3. Is the project financially sound?

A key recommendation of the Report[33] is the adoption of ARTAG by Australian Governments. The Report also identifies:

- *The explicit purpose of ARTAG is to engender a National approach to assessing applications for Rapid Transit infrastructure funding from State Governments seeking financial support from the Commonwealth Government.*
- *ARTAG can be equally useful as a tool to assist in the development of Rapid Transit project proposals by State and Local Governments. It is intended that by satisfying the pre-conditions required for high value ratings in the ARTAG model, the project proponent can identify good design principles for Rapid Transit Projects.*

ARTAG comprises three ratings mechanisms:

- Project Preconditions Rating (40 per cent)
- Project Justification Rating (40 per cent)
- Project Financial Rating (20 per cent)

Final Project Rating = Project Preconditions Rating + Project Justification Rating + Project Financial Rating (100 per cent).

The <u>initial Study and this Annexure are consistent with the ARTAG Model</u>. That is, the project preconditions were based on current need and NSW Government key policies and initiatives influencing the development for Parramatta Road including:

- A Plan for Growing Sydney
- Draft Central District Plan
- Sydney CBD to Parramatta Strategic Transport Plan
- Parramatta Road Urban Transformation Strategy
- WestConnex
- Additionally the impact of the CBD and South East Light Rail, and the potential Parramatta Light Rail and West Metro were considered.

It is therefore apparent that there is a sound basis for the comparison of the proposed RBS and GETS.

[33] Rapid Transit Investing in Australia Transport Future (Report prepared for Infrastructure Australia by BIC 2014).

# 5. COMPARISON - COUNCILS' PERSPECTIVE

The Councils requested examination of the RBS and GETS with regard to particular attributes, viz:

i. Parking allocation
ii. Land acquisition
iii. Fleet size and vehicle models
iv. Examples of where GETS technology is already operating
v. Demand Community acceptance -
   a. branding and promotional appeal Mode shift
   b. service frequency and so on
vi. Trip duration
vii. Implementation
viii. Network integration and interchange
ix. Station stops - spacing, form and function
x. Consumer experience, choice and perception
xi. Activation of street- frontage uses
xii. Land Development

Each of these attributes is considered below in terms of recent relevant research, studies and industry experience. In many instances this serves to highlight key points of difference between the RBS and GETS. <u>It should though be noted that it is the total systems view that is relevant as distinct from focussing on any one attribute in isolation</u>.

**(i) PARKING** allocation - It is suggested the GETS would benefit from provision of parking for shared vehicle (eg GetGo and taxis) and bicycle parking and the use of the kerbside lanes for off-peak short term parking. Short term parking will assist to re-invigorate commercial and retail tenancies, buffer pedestrians from traffic, enable traffic management options at peak periods.
**Overall** - Kerbside parking is considered to be advantageous. A RBS running kerbside would preclude this option - GETS accommodates opportunities for kerbside parking.

**(ii) LAND** acquisition - Is likely to be greater for the GETS due to station infrastructure and the possible acquisition or ceding of land at some stops to enable better station locations. There is a commercial advantage relating to the location of stops and previous planning has found that landowners are prepared to cede land to accommodate the stop or achieve some other concession. Examples such as the bus service upgrade undertaken in Florida indicate that, if all else stays the same, state of the art stations and vehicles increase patronage (by 33% in the case of the Florida experience).
**Overall** - Minimal land acquisition would be required for either option. However, there will be higher costs associated with station infrastructure which may also include service relocation and land acquisition to accommodate centrally located higher order stations. With judicious selection of particular station sites (superstops) additional redevelopment opportunities (as per PRCUT Strategy) can be activated – less relevant to the kerbside RBS as compared to centre-running GETS.

**(iii) FLEET** size and vehicle models - The fleet size of both the RBS and GETS options is dependent upon demand modelling and frequency of service. The indicative GETS fleet size in the initial Study Report was for 30 bi-articulated 24 metre long vehicles to service a 20 kilometre route. It is noted that a range of vehicles may be considered to service the trunk route and spur lines providing capacity suited to demand.

A useful document for the comparison of Bus Rapid Transit type vehicles (such as those of the RBS and GETS options) is the Bus Rapid Transit Compendium 2006 (provided in Appendix A). *Although some information is outdated, this document prepared by WestStart-CALSTART, in partnership with the USA Federal Transit Administration (FTA) provides summary information about vehicles offered for Bus Rapid Transit service by various vehicle manufacturers, both U.S. and foreign. The Bus Rapid Transit Compendium describes vehicles in the following categories of 1) conventional standard, 2) stylized standard, 3) conventional articulated, 4) stylized articulated and 5) specialized.*

**Overall** - For a given demand the vehicle capital cost for GETS is likely to be not significantly more than for the RBS option due to the additional passenger capacity of the larger vehicles. Operating costs will be significantly less. There are several options for Bus Rapid Transit vehicles ranging from standard buses to highly stylised bi-articulated vehicles. In general terms to meet peak demand of 5,000 people per hour approximately 70 standard buses would be required as compared to approximately half that number of GETS vehicles. Total fleet cost is similar with the standard being approximately half the price of the GETS.

**(iv) GETS EXAMPLES** - Early GETS type vehicles includes the Philaes and the Civis Irisbus. Both these vehicles have been deployed in Europe and the USA (Philaes in Eindhoven in the Netherlands and Douai in France and Civis Irisbus in Rouen France and Las Vegas in the USA). Specialised vehicles include guidance systems, such as the Philaes with magnetic guidance and the Irisbus with optical guidance. The vehicle guidance has been used to meet one or more of a variety of objectives, including to reduce right of way requirements, to provide a smoother ride and to facilitate "precision docking" at stations, allowing no-step boarding and alighting. Other stylised vehicles without guidance include the Wrightbus deployed by RTC in Las Vegas and the Nabi 60 used on the Orange Line in Los Angeles and the New Flyer on the Healthline Cleveland. (Further examples are also included in the following sections) Several evaluation studies of BRT note the success of these specialised or stylised vehicles in attracting ridership and supporting urban regeneration. Factors for this success differ but include the differentiation from normal buses and the perceived level of permanence and commitment. In all cases increased ridership and land development has resulted in additional routes being implemented with similar vehicles.

**(v) DEMAND**

**Demand and Community acceptance** More recent examples include Nobino in Malmo, an early adopter of the latest design Van Hool GETS style vehicle taking delivery of 15 vehicles in 2014. The Swedish Government has subsequently ordered another 20 vehicles to be delivered 2019 due to the success and popularity of vehicles. The growth of 12% in ridership is significant in a city where public transport use was already high and is considered attributable to the high level of amenity provided by the electric (trambus style) vehicle. Another example is Mettis in France where the successful introduction of a diesel-electric hybrid version of the 24 metre vehicle in 2013 resulted in a 33% increase in ridership in the first year. The Van Hool trambus styled vehicles are currently operating in Barcelona, Parma, Mettis, Geneva, Luxembourg, Malmo, Martique and Hamburg. In 2017 Hamburg will be the first city to introduce a fleet of on-route quick charging fully electric vehicles. Various state of the art Electric Vehicles are available from several manufacturers and more are being released.  Charging systems are often broadly compatible and as are guidance systems that can be retro fitted as required.

Studies undertaken in USA and Canada and in Australia suggest that vehicle design greatly impacts user perceptions addressing partly the association with it being a bus.  Where there has been greater differentiation between the BRT system and the regular bus service community acceptance has been greater.  This was bus bias was demonstrated in a blind study where people did not know if they were rating a LRT or BRT system and later told and allowed to revise their scoring.  In Brisbane where there was greater knowledge and usage of BRT the results were more favourable to BRT this was referred to as the Brisbane effect[34].

Lessons learned from previous implementation of specialised vehicles point to the importance of communications and branding. In Las Vegas the RTC MAX ran a comprehensive campaign promoting their new system resulting in high customer satisfaction and acceptance.  In Los Angeles the implementation of the Orange Line was initially opposed as the community wanted light rail. The lack of engagement, no clear delineation between bus and BRT resulted in a lobby group forming in opposition and bad press.  Once implemented the level of success resulted in a response from those lobbying for light rail that the increased ridership proved light rail would have been appropriate.  Subsequently other BRT lines have been added with a high level of acceptance.

**Demand and mode shift**.  There are several examples where modern transport has encouraged mode shift as reported in the Brisbane study (Lord Mayors Taskforce Brisbane Mass Transit Investigations), Malmo and other examples mentioned previously.  The Table below[35] provides an understanding of the relative priority of drivers of elements underlying patronage.  Of note ‘Service Frequency’ is identified as a high priority, however it is important that it not be considered in isolation.  It is the total suite of service attributes that must be managed.  Along Parramatta Road especially the eastern section service frequency at peak is very high with several routes utilising this corridor.  However the dedicated lanes at peak and this high frequency has not supported business or achieved a high level bus ridership.

***Table1: Core Elements Underlying Patronage on Rapid Transit***

| Element | Description | Impact |
| --- | --- | --- |
| Service Frequency | Scheduled frequency of service along routes of operation. At optimal levels during peak this means an effective “timetable free” frequency, for example a bus every five minutes on a Bus Rapid Transit system.<br>This creates an intuitive understanding amongst users of the availability of transport and can feed into perceptions of service convenience and quality. | HIGH |

[34] Identifying resident preferences for bus-based and rail-based investments as a complementary buy in perspective to inform project planning, Journal of Transport Geography 46 (2015)

[35] Extract from: Rapid Transit Investing in Australia Transport Future (Report prepared for Infrastructure Australia by BIC 2014).

| | | |
|---|---|---|
| Service Coverage | Geographical coverage of the service and span of hours of operation. Span of hours in particular can influence user perceptions of service quality. | HIGH |
| Service Quality | Customer service levels, user perceptions of safety on board vehicles and user perceptions of safety and amenity while waiting at stations influence the ability of Rapid Transit systems to attract new passengers. Ride comfort can relate to the use of new vehicles with modern design and engineering for improved comfort on Rapid Transit systems. | HIGH to MEDIUM |
| Service Information | The availability of information on services and timetables to users also plays a role in perception of service quality and the ability of this element to influence patronage. As highlighted previously, the adoption of a timetable free system on Rapid Transit systems will improve the perception of service quality. | HIGH TO MEDIUM |
| Residential Density | Residential densities and population in the areas of operation. Indicative densities required before the construction of Rapid Transit systems are encompassed in the ARTAG model. | MEDIUM |
| Employment Density | Prevalence of commercial property in the areas of operation. Indicative densities required before the construction of Rapid Transit systems are encompassed in the ARTAG model. | MEDIUM |
| Service Cost | Fares, relative cost of service to other modes. | MEDIUM TO LOW |
| Travel Time Savings | Door to door ride time for passengers and improvements relative to pre-existing forms of public transport and competing modes of transport including walking, cycling and cars. | MEDIUM TO LOW |

Source: Rapid Transit Investing in Australia's Transport Future p78

**(vi) TRIP DURATION** - The following Table shows the various trip duration estimates based on current performance and case studies. The times shown in blue are the estimates provided showing before and after Westconnex. It is noted that the time for the RBS is based on the initial staging without station stop infrastructure including platform level boarding and off board fare collection. There will be no signal priority and the route will be constrained by other buses potentially stopping at all stops using the same corridor resulting in a travel time similar to existing.

**Table 2: Trip Duration Estimates**

| Burwood Station to Central Station at Hay Street via Parramatta Road | | |
|---|---|---|
| **mode** | **Trip duration (mins)** | **Service frequency (mins)** |
| Car | 25 | NA |
| Bus (461) | 42 (47) | 10-20mins |
| RBS | 42 (26) | 10mins 6am to 7pm |
| Get | 26 30 | 2-6mins |
| Train | 12 | 6-15mins |
| Bicycle | 37 | NA |

The GETS is not primarily intended to service the needs of point to point commuter travel, from the suburbs into the CBD. This is much better served by metro and heavy rail with a 12 minute trip as opposed to 30 minutes (estimate of GETS).  However, the GETS does offer potential as an alternative corridor (to metro and heavy rail) to link key employment centres between the Sydney CBD and Parramatta CBD.  This would promote agglomeration and so benefit business and support economic development.

**Overall** - The GETS is more efficient and has a higher capacity than the RBS.

## (vii) IMPLEMENTATION

**Cost comparison** – It should be noted that there are variations amongst the numerous sources of information regarding performance and costs (capital and operating) for both the RBS and GETS. These variations can to some extent be explained in terms of there being differing circumstances upon which the information has been determined.

Accordingly the most recent and relevant sources of information have been used. The information in the following Table is drawn from The Lord Mayor's Taskforce Brisbane Mass Transit Investigation: Options for Consideration (September 2007) and the Infrastructure Australia Report Rapid Transit Investing in Australia Future (2014) as well as a recent (January 2017) advice from Van Hool (inclusive of cost estimates, implementation program options and deployment performance experience).

**Table 3: Cost Comparison**

| Comparison Table | | |
|---|---|---|
| **Element** | **RBS** | **GETS** |
| Vehicle | $312,000 | $700,000- $1,200,000 |
| Operating Cost | $9-19pvkm | $4.50 |
| Persons per vehicle | 60 | 150 |
| Route max capacity | 5,000pphpd | 10,000pphd |
| Road construction Cost | $.39-$.78 pkm | $.39-$.78 pkm |
| Turning radius | 20 m | 12.2m (24m vehicle) |
| Mode shift | Minimal | 24%-56%(Australian Study Currie and Sarvi 2012) |

The RBS option (per PRCUT Strategy documents) includes $132M allocation for vehicles and stops. A comparative estimate of $200M for GETS includes station infrastructure and electric charging infrastructure, depot and stations. It is noted that the GETS has a higher initial cost but that this is more than offset over the long-term through lower operating costs (including fuel and maintenance) and higher passenger capacity.

**Overall** - the GETS provides a greater Return on Investment (than the RBS) when all factors are considered over the life of the investment inclusive of those benefits that can be difficult to monetise.

### Case Study Examples

Systems visited on the BIC's Rapid Transit Study Visit of North America were among those assessed in a 2013 case study of 21 Rapid Transit systems across 13 US and Canadian cities. The study undertaken by the Institute for Transportation Development and Policy (IDTP) found that per dollar invested:

- *Bus Rapid Transit leverages more transit-oriented development investment than Light Rail or streetcars.*
- *Cleveland's HealthLine Bus Rapid Transit and Portland's MAX Blue Line Light Rail leveraged the most overall Transit Oriented Development investment of all the corridors studied — $5.8 billion and $6.6 billion, respectively. Yet, because the HealthLine Bus Rapid Transit cost significantly less to build than the MAX Blue Line Light Rail, Cleveland's*

*HealthLine Bus Rapid Transit leveraged approximately 31 times more Transit Oriented Development investment per dollar spent on transit than Portland's MAX Blue Line Light Rail.*

- *Both Bus Rapid Transit and Light Rail can leverage many times more Transit Oriented Development investment than they cost.*
- *Of the 21 corridors studied, 14 leveraged greater than $1 of Transit Oriented Development investment per $1 of transit spent. Five of them were Bus Rapid Transit, four of them were Light Rail, two were streetcars, and three were improved bus (non-Bus Rapid Transit) corridors.*
- *Government support for Transit Oriented Development is the strongest predictor of success.*
- *A government that sees potential in a site for development can provide a range of support from regulatory changes to financing to marketing of the area. There is nearly a direct correlation between the level of Transit Oriented Development investment and the strength of government support. If a government does nothing to support Transit Oriented Development along the transit corridor, there will be no Transit Oriented Development impact.*
- *The strength of the land market around the transit corridor is the secondary indicator of success.*
- *Where governments provide moderate support for Transit Oriented Development, the existing market strength of the land determines the level of Transit Oriented Development investment. Today, downtowns tend to be strong land markets, so having the transit investment pass through downtown leads to better Transit Oriented Development impacts*.(IDTP 2013)

**(viii) NETWORK integration and interchange ability with current and future systems** - In comparing the two, both RBS and GETS provides for network integration at key points and it is important that local services feed into the corridor - this is the least point of difference and it is noted that network changes have been identified as being required in the implementation of the RBS.

**(ix) STATIONS form and function** – stop spacing is a decisive element in distinguishing light rail and rapid bus systems from existing bus and tramways. It is assumed that the stops spacing will be the same for RBS and GETS. It is more the form of stations that is the point of difference which provides greater efficiency with off board ticket validation, bike share facilities and platform level boarding.
**Overall -** GETS on a central running figuration is far more conducive to mode shift, street front activation and overall urban transformation.

**(x) CONSUMER choice and perceptions –** If the public transport service provides the required frequency, reliability and quality of service (stations, ride comfort and safety) it will attract ridership. However recent examples such as fleet upgrades in Malmo and Las Vegas. Nevada suggest that vehicle design is critical in transitioning the customer perception away from the service being merely a bus to that of a higher level transit system. *Due to the Las Vegas community's appreciation for advanced technology and innovative* *solutions, planners at the Regional Transportation Commission (RTC) of Southern Nevada developed a branding specification that highlighted all aspects of an alternative transit experience. The MAX system combined a sleek, state-of-the art vehicle, uniquely designed passenger stations, and an exclusive marketing campaign, to introduce the service and educate citizens and visitors alike regarding Bus Rapid Transit in the Las Vegas metropolitan area*[36]*.* The Max runs at 11minutes frequency in dedicated lanes in mixed traffic.

**(xi) ACTIVATION Why a basic rapid bus system won't activate Parramatta Road** - The RBS is quite similar to what is currently in place along the eastern sections of Parramatta Road that have dedicated bus lanes and high frequency service during peak periods. That is, two of the most important factors in a successful bus rapid transit. What is demonstrated by the current patronage and corridor conditions (vacancy rates, land usage, and so on) is that these factors are not sufficient to bring about transformation. What is required is a high quality and reliable service inclusive of station infrastructure and vehicle appeal that is required to realise the desired changes. Replacing the current buses with a branded bus that is not significantly different and will not achieve urban transformation. Such change requires dedicated lanes a with signal priority, station infrastructure and so on as previously identified earlier in this in Section (Bus Rapid Transit Standard & Scorecard).

**Overall** – GETS is consistent with the desired urban transformation scenario. This is in stark contrast to the <u>RBS</u> option which is essentially a *business as usual* scenario – essentially 'doing the same thing but expecting a different result'.

**(xii) Land Development**

The following BRT elements provides transit-supportive land development. These elements can generally be classified into three categories:

- Generative impacts - produce net economic growth and benefits in a region such as travel time savings, increased employment and income, improved environmental quality, and increased job accessibility. This is the only type of impact that results in a net economic gain to society at large.
- Redistributive impacts - account for locational shifts in economic activity within a region such that land development, employment, and, therefore, income occur at transit stations along a route, rather than being dispersed throughout a region.
- Transfer impacts - involve the conveyance or transfer of moneys from one entity to another such as the employment stimulated by the construction and operation of a transit system financed through public funds, joint development income, and property tax income from development redistributed to a transit corridor through station development.

Examples of land development and property value uplift of BRT include:

- Ottawa, Canada Transitway system new development with an aggregate value of over $675 million (US$) in the first 15 years after the transitway system was constructed.

[36] Characteristics of Bus Rapid Transit for Decision-Making

- MBTA indicates $700 million in new development and construction around Silver Line BRT stations to date.
- Residential properties within walking distance of stations on Brisbane's SE Busway increased in value 20 percent faster than properties in the same corridor not in walking distance.

There are three design elements that contribute to land development dedicated lanes, station design and vehicles.

**Dedicated lanes -** Research shows that the effect of investments in dedicated lanes is three-fold.

- They improve the convenience
- Increased accessibility increases the likelihood that property development to a more valuable or more intense use.
- Physical running way investments signal to developers that a government is willing to invest and suggest a permanence that attracts private investment in development.

**Stations -** Station design has the greatest impact on the economic vitality of an area. A new BRT station provides opportunity to enhance travel and create a liveable community at the same time. Station designs that effectively link transit service to the adjacent land uses maximize the development potential. It is important to note that the inclusion of routes in BRT systems that combine feeder service reduces the need for parking, thereby freeing the most accessible for development.  Stations Stops Investment in public transit facilities such as stations or other transit infrastructure can create a net economic regional impact as well as a direct net impact for transit system customers by allowing increased access to jobs and other services as well as improved mobility. Supported by increased pedestrian activity and transit customers, a mix of employment, retail and leisure activities develop around BRT stations. In many BRT systems, transit-oriented development is being used as a tool to encourage business growth, to revitalize aging downtowns and declining urban neighbourhoods, and to enhance tax revenues for local jurisdictions.

**Vehicles -** Vehicles can reinforce attractiveness (and, indirectly, the development potential) of BRT-adjacent properties to the extent that they:

- Demonstrate attractive aesthetic design and support brand identity of the BRT system
- Suggest permanence or a willingness on the part of the public sector to invest in the community
- Reduce negative environmental impacts such as pollutant emissions and noise.

Experience in Boston and Las Vegas suggests that property developers respond to services that incorporate vehicles that are attractive and that limit air pollutant and noise emissions. Successful developments in Pittsburgh and Ottawa, Canada, where more conventionally designed vehicles are deployed suggests that development can still occur with all vehicle types as long as service improvements include development of high quality stations and significant landscaping to highlight the attractiveness of station locations. (It is our understanding that in the short term the RBS vehicles and stations types will not be consistent with promoting land development.)

BRT vehicles are classified under 5 categories standard, standard stylised, articulated, articulated stylised, specialised. The RBS would be classified as standard stylised and the GETS as specialised. More information on the attributes of each type of vehicle category is provided in the BRT Compendium Appendix A.

**SUMMARY OF KEY DIFFERENCES**

GETS as compared to RBS:

- Scalable –greater diversity of vehicles
- Higher passenger capacity per vehicle will meet needs of future demand. Capacity required for the Parramatta Road Bus Rapid Transit was advised to be in the order of 5,000pphpd*by 2020. This would result in standard buses platooning along the eastern sections of Parramatta Road. (*pphpd denotes people per hour per direction)
- Distinctive and innovative vehicle design (defined as *Specialised Vehicle* in the BRT Compendium )
- High level of service and comfort
- Reduced environmental impacts - less noise and air pollution
- Reduces number of vehicles on corridor and entering into the city. Frequency will still be consistent with high quality service.
- Supports development and urban regeneration
- Low risk but high level transport innovation that potentially provides broad community benefits
- Unlocks investment potential encourages local economic development sooner providing greater return on investment
- Dedicated lanes and centre running demonstrates the higher priority of public transport over private transport
- Opportunity for integration with other electric vehicles and non-motorised transport to provide a distinctive innovative network for the Inner West
- Opportunity for NSW to lead transport design with a contained transport innovation project
- Genuinely accessible vehicles.
- Environmentally friendly vehicles
- Quieter vehicles
- Demonstrates innovation

# 6. COMPARISON - ITDP STANDARD & SCORECARD

By considering RBS and GETS as being variations within the Bus Rapid Transit (BRT) category of public transport systems an international BRT Standard and associated Scorecard can be utilised. It is comprehensive and reflects current best practice and so provides for a rigorous objective and transparent basis for comparison. The BRT Standard Scorecard ratings of the RBS and GETS enable key difference to be identified and interpreted.

The Institute for Transportation and Development Policy (ITDP), an international non-profit organisation based in New York, has developed an internationally recognised Standard that measures best practice for Bus Rapid Transit. This Standard is used as a common definition for Bus Rapid Transit and enables Bus Rapid Transit systems to more uniformly deliver world-class passenger experiences, significant economic benefits, and positive environmental impacts.

*Bus Rapid Transit (BRT) is a bus-based rapid transit system that can achieve high capacity, speed, and service quality at relatively low cost by combining segregated bus lanes that are typically median aligned with off-board fare collection, level boarding, bus priority at intersections, and other quality-of-service elements (such as information technology and strong branding).*(BRT Scorecard 2016)

The Standard and associated Scorecard (based on a 100 point rating scale) enables certification of a Bus Rapid Transit corridor as: Gold (85 points or above); Silver (70-84 points); Bronze (50-69 points); or Basic.

The various elements and the scoring for each are explained in the Standard (Appendix B). In broad terms the Scorecard 100 point rating scale is assigned across various Design components. There is also an Operations Deduction provision whereby the scoring of the various Design components can be reduced (by up to 63 points) based on actual or anticipated performance. The Design and Operations Deduction components are outlined below. Further guidance on scoring elements is provided in the Standard.

Minimum Requirements for a Corridor to be considered Bus Rapid Transit:
1. At least 3 kilometres in length with dedicated lanes
2. Score 20 or more total points across all five BRT Standard basics elements.
    - Dedicated Right-of-Way maximum 8 points (must score at least 4 points)
    - Busway Alignment maximum 8 points (must score at least 4 points)
    - Off-Board Fare Collection maximum 8 points
    - Intersection Treatments maximum 7 points
    - Platform-level Boarding maximum 7 points

Added to the score achieved for the above basic requirements are those scored in the categories below (Note: each category is comprised of a number of associated elements described in full in the Standard and included in point form on the Scorecard overleaf) :

- Service planning maximum 19 points
- Infrastructure maximum 13 points

- Stations maximum 10 points
- Communications maximum 5 points
- Integration and access maximum 13 points

When operational up to 63 points can be deducted for the following:

- Low commercial speeds: minimum average commercial speed below 13 kph -10 points
- Peak passengers per hour per direction (pphpd) below 1,000 -5 points
- Lack of enforcement of right-of-way -5 points
- Significant gap between bus floor and station platform -5 points
- Overcrowding -5 points
- Poorly-maintained infrastructure -14 points
- Low peak frequency -3 points
- Low off peak frequency -2 points
- Permitting unsafe bicycle use -2 points
- Lack of traffic safety data -2 points
- Bus running parallel to Bus Rapid Transit corridor-6 points
- Bus bunching -4 points

Assessment of the RBS and GETS options in accord with the Scorecard is provided in the Table overleaf.

### Comparative Analysis

The information relating to the Rapid Bus Service (RBS) option has been somewhat limited. This may be a consequence of the proposal for a RBS being at a preliminary stage of development or that there are restrictions on dissemination of information. Nonetheless the comparative analysis has been undertaken based on the RBS option as best the details can be determined, through publicly available documentation and discussions with TfNSW. As more information becomes available about the RBS option then this comparative analysis could be readily revisited should it be the case that it differs significantly to that assumed in this research.

Of the 30 scoring elements of the BRT Standard Scorecard the first 5 elements are classified as the BRT Basics. A system must achieve a minimum of 20 points to be considered a BRT system. The RBS did not attain the minimum of 20 points to be designated as a BRT. However the full evaluation of both systems RBS and GETS was completed to provide further insight to inform the comparative analysis. The RBS and the GETS differed in only 11 elements hence it could be said that it has more similarities than differences. However those 11 points of difference result in the GETS being rated as a gold standard system and the RBS although scoring 53 points which would classify it as Bronze (with basic eligibility). The 11 elements of difference include:

- **Busway alignment**
- **Off board fare collection**
- **Intersection treatment**
- **Platform level boarding**
- Bus emissions

- Centre stations
- Safe and comfortable stations
- Number of doors on the bus
- Docking bays and sub stops
- Branding
- Universal access
- Pedestrian access and safety

The bolded elements are those BRT Standards specifies as being basic minimum requirements. The RBS scored only 10 of the required 20 points and would not qualify for BRT certification. To attain the basic level to be classified as Bus Rapid Transit the RBS as described in the PRCUT Strategy would need to include 2 of the following elements centre running, signal priority, or platform level boarding. If the RBS had scored full points for off board ticket validation it would only require one of the above elements.

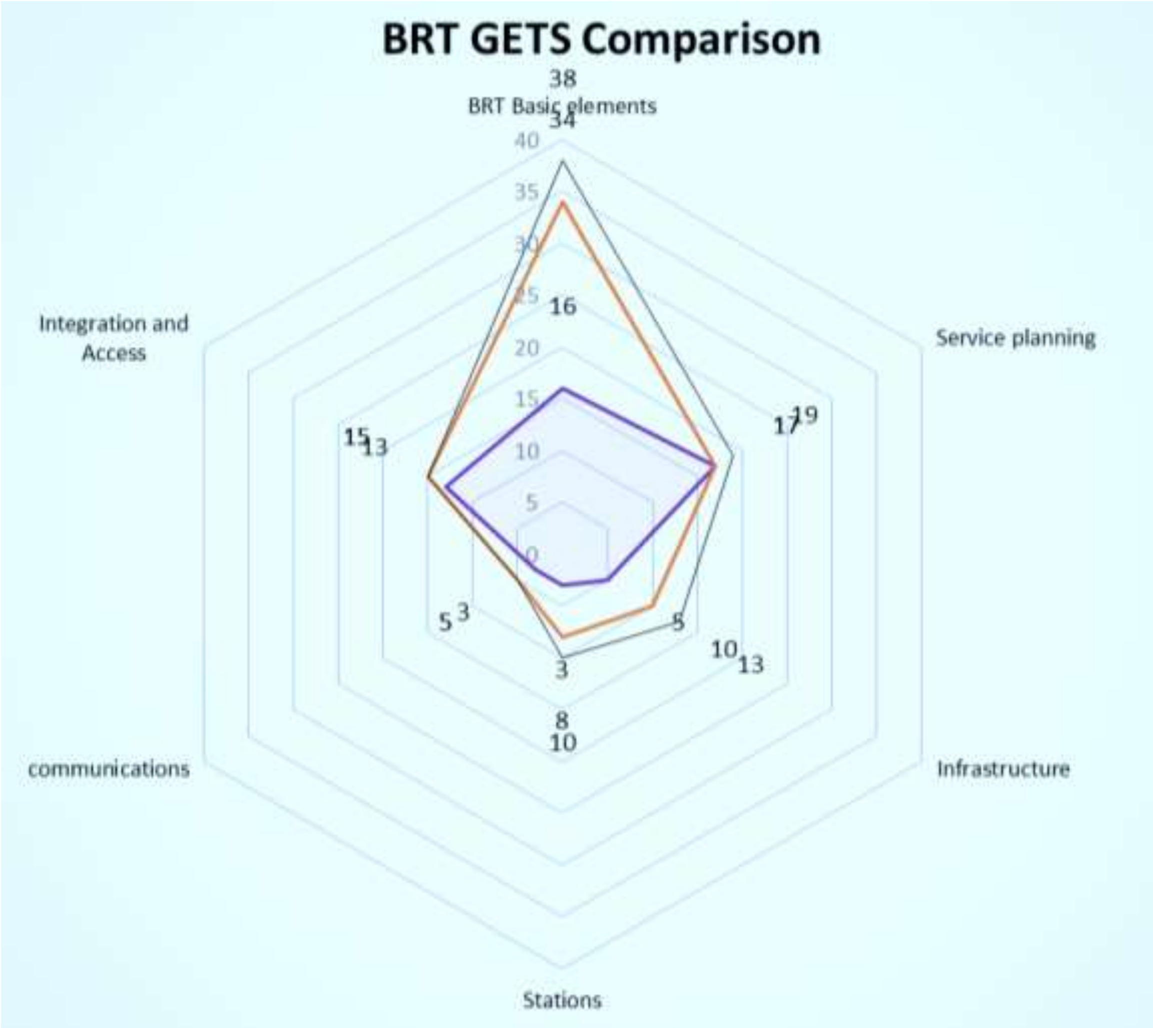
These 11 elements of difference are considered in detail in the following Table. There are many blank sections of the scorecard as these are areas where both were similar.

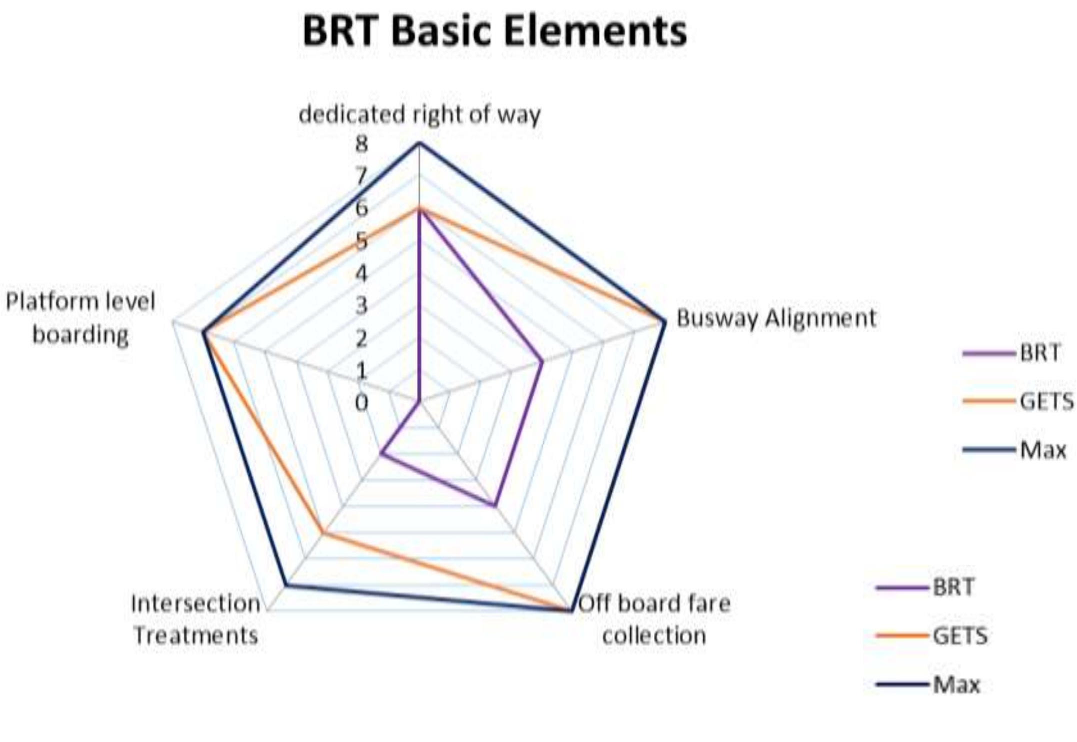
| BRT SCORECARD BRT STANDARD 2016 | | | |
|---|---|---|---|
| **CATEGORY - max score** | **RBS** | **GETS** | **Comment** |
| **BRT Basics** | | | |
| Dedicated Right-of-Way 8 | 6 | 6 | Assuming both in dedicated lanes – painted pavement. |
| Busway Alignment 8 | 0 | 8 | The centre running is preferred as this minimises conflicts with other traffic and particularly turning vehicles and those entering from driveways and lanes. Also it leaves the kerbside lane for taxi pick-ups, emergency vehicles, deliveries, short-term parking and demand management of traffic at peak. |
| Off-Board Fare Collection 8 | 4 | 8 | Differs between the GETS and the RBS as described above. Potential that the RBS could have off-board validation at stops or through the new contactless payment systems currently being explored by TfNSW. Would result in 4 of the required 10 points being achieved by the RBS. |
| Intersection Treatments 7 | 2 | 5 | GETS only scored 5 points as it was considered that some turning across the route would be required for north south movement however signal priority was considered important. The RBS does not have signal priority. TfNSW it is considered that signal priority on Parramatta Road would impact network performance. However TfNSW advises that some form of signal priority may be achievable. The signal phasing is currently 110 seconds (commonly 55 seconds) at this spacing it may be feasible to give priority 2 out of 3 cycles. The Kerb running RBS has the option of allowing all turning vehicles. There is currently a traffic management system that enables signal priority to avoid bunching. |
| Platform-level Boarding 7 | 0 | 7 | The RBS has a large gap between bus and pavement this can be managed with a ramp and squatting to provide universal access but it is slow and there are passenger injury risk and slower boarding. The GETS has a guided system to ensure accurate smooth docking |
| **Total (max 38)** | **12** | **34** | **RBS does not meet minimum BRT requirements** |
| **Service Planning** | | | |

| | | | |
|---|---|---|---|
| Multiple routes 4 | 4 | 4 | |
| Express, limited, and local services 3 | 2 | 2 | |
| Control centre 3 | 3 | 3 | |
| Located In top ten corridors 2 | 2 | 2 | |
| Demand Profile 3 | 3 | 3 | |
| Hours of operations 2 | 2 | 2 | |
| Multi-corridor network 2 | 1 | 1 | |
| **Total (max 19)** | **17** | **17** | |
| **Infrastructure** | | | |
| Passing lanes at stations 3 | 1 | 1 | |
| Minimizing bus emissions 3 | 0 | 3 | RBS is a standard diesel bus and did not score - GETS is an electric or hybrid electric this provides less noise and air pollution. |
| Stations set back from intersections 3 | 3 | 3 | |
| Centre stations 2 | 0 | 2 | 2 points awarded to GETS as it is proposed to have a central stations that service both directions. Station design and placement is important as it provides a sense of permanence and commitment and differentiation from standard bus services. To some degree this can be achieved through good landscaping and urban design at kerbside but does not have the same level of advantages hence the scorecard only provides points for centre stations. |
| Pavement quality 2 | 1 | 1 | . |
| **Total (max 13)** | **5** | **10** | |
| **Stations** | | | |
| Distances between stations 2 | 2 | 2 | 800m -1km as per superstops |
| Safe and comfortable stations 3 | 0 | 3 | GET attained the 3 points as the stations would be weather protected and have seating, bike share facilities and bike parking and some landscaping. RBS is reported to have shelters and seating at some stops and would not provide the same level of customer amenity. The style of station is an important element in providing a sense of quality, permanence, legibility and branding. |
| Number of doors on bus 3 | 0 | 3 | According to the standard the vehicle needs to have at least 3 doors to qualify for the 3 points. GETS vehicle will have multiple doors and will require doors on both sides so that it can operate across the network area. The multiple doors provide increased safety in emergency evacuation, improves boarding times, better utilisation of space, and improved passenger comfort and enables better utilisation of bus capacity for standing passengers. |
| Docking bays and sub-stops 1 | 1 | 0 | 1 point if stations have 2 or more docking bays. RBS will have docking bays. GETS not yet decided. |
| Sliding doors in BRT stations 1 | 0 | 0 | |
| **Total (max 10)** | **3** | **8** | |
| **Communications** | | | |
| Branding 3 | 1 | 3 | The maximum three points was awarded to the GETS as it is envisaged that all vehicles stations and routes in the corridor will be branded. RBS scored 2 points as it is intended that the RBS be branded but the route will also continue to carry non branded buses. There are currently 26 routes that converge into Parramatta Road it is intended that there will be under both |

| | | | |
|---|---|---|---|
| | | | scenarios a rationalisation of the network. |
| Passenger information 2 | 2 | 2 | |
| **Total (max 5)** | **3** | **5** | |
| **Integration and access** | | | |
| Universal access 3 | 2 | 3 | The maximum of 3 points was awarded to the GETS as it will have level boarding with no significant gap or steps. The station will have ground surface indicators and audible sounds to alert passengers of the arrival of the vehicle this is particularly important for electric vehicles due to the silent nature of it operation. The RBS has lesser accessibility with no footpath treatments and no audible announcement of vehicle arrival and route. |
| Integration with other public transport 3 | 3 | 3 | |
| Pedestrian access and safety 4 | 3 | 4 | RBS has easier access being on the kerbside but has the risk of pedestrians falling or stepping out in front of the bus. The GETS was given 4 points because it has controlled station access for pedestrian, great traffic separation and signalised pedestrian crossing. |
| Secure bicycle parking 2 | 2 | 2 | |
| Bicycle lanes 2 | 2 | 2 | |
| Bicycle-sharing integration 1 | 1 | 1 | |
| **Total (max 15)** | **13** | **15** | |
| **TOTAL 100** | **53** | **89** | **GETS gold standard BRT (85-100 points)**<br>**RBS does not meet basic requirements** |

The above Scorecard is presented diagrammatically below.


BRT GETS Comparison
BRT Basic elements
Service planning
Infrastructure
Stations
communications
Integration and Access
38
34
16
19
17
10
13
5
8
10
3
5
3
15
13
40
35
30
25
20
15
10
5
0


BRT Basic Elements
dedicated right of way
Busway Alignment
Off board fare collection
Intersection Treatments
Platform level boarding
8
7
6
5
4
3
2
1
0
BRT
GETS
Max
BRT
GETS
Max

### Summary of Comparative Analysis

The GETS offers significant advantages as compared to the RBS. In summary these include:

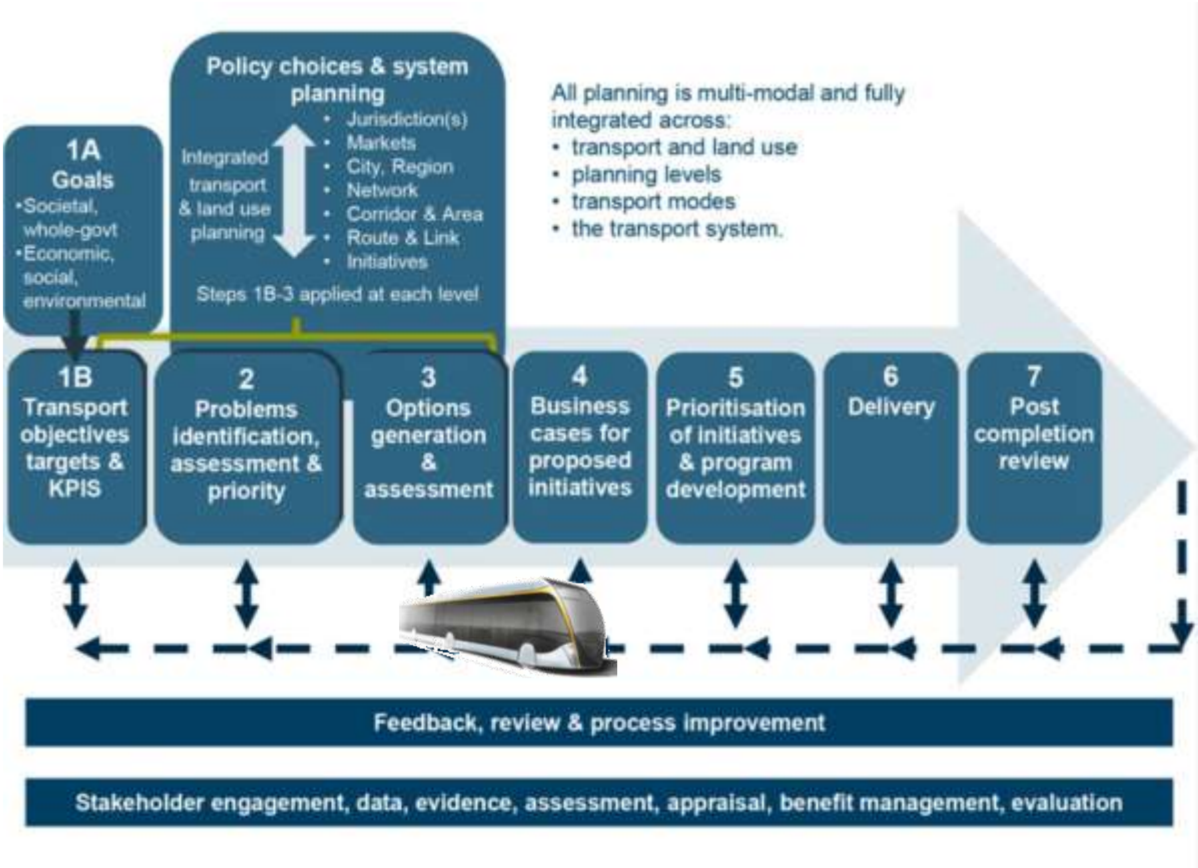
- Mode Shift – Attractive, comfortable, quite, non-polluting, reliable, frequency
- Capacity- Where the higher capacity vehicles are currently deployed additional higher capacity vehicles are introduced to the system as required to meet increased demand generated through mode shift, employment aggregation and infill development. (This will also assist in maintaining acceptable frequencies for the service.) The fleet composition and service frequency can also be managed to meet peak demand or to cater for occasional events. Smaller vehicles can be used for off peak periods. Being road based vehicles enables network expansion and incremental growth.
- Return on Investment – demonstrated good return on transport investment due to property value uplift, land development, business and commercial development, increased employment
- Minor construction Impacts
- Short Implementation Time. As address previously a short implementation time is particularly important for Parramatta Road where achieving mode shift from private vehicles will assist to address traffic impacts from WestConnex staged construction program and provides opportunity to capture spare capacity, address latent demand and return the road to a transit corridor where the movement of people not vehicles is the primary objective.

These and other aspects are best elaborated by way of further detailed investigation.

# 7. NEXT STEPS

The initial Study was required to examine the opportunities for Light Rail along Parramatta Road. That is, it concerned a particular option to improve public transport. However, a necessary first step of the Study was to determine the policy and planning context, and world's best practice in the provision of public transport to catalyse urban regeneration – as specified in the Study Brief. On the basis that the context had been thoroughly identified and considered, the opportunities for Light Rail were evaluated. In doing so, other options preferable to Light Rail became apparent. Hence the recommendation to further investigate GETS.

The approach that was adopted in the initial Study was in effect highly consistent with that shown in simplified schematic form below. This is the 'Transport Assessment & Planning Framework' advocated in the Guidelines of the Transport and Infrastructure Council (Commonwealth of Australia 2016).




As indicated in the schematic (above) the initial Study together with this Annexure have progressed to #3 'Options Generation & Assessment'. The options include the RBS (as proposed by the NSW Government), Light Rail and GETS. It is quite apparent that the next steps concern #4 'Business Cases for Proposed Initiatives'. A pragmatic way forward is to consolidate #3 then proceed into #4 by way of the NSW Government commitment to undertake the Burwood – Sydney CBD On Road Transit (BSORT) project. The Councils are (through the initial Study and this Annexure) well-placed to proceed on that basis – proactive productive participants in the BSORT project.

## 8. CONCLUSIONS & RECOMMENDATIONS

The findings of this comparative analysis (and the major report) indicate that it would be appropriate to include GETS within the NSW Government's commitment to *investigate a rapid bus service or an alternative public transport solution*[37]. The Councils are well-placed through their initial Study together, with this further research, to productively contribute to that investigation.

However, it is imperative for the Councils to quickly engage with the State in that investigation. This is a consequence of there being indications that the State has already progressed to the stage of firming to 'the' solution being a rebadging of existing bus services purporting to be a Bus Rapid Transit.

Also, through the WestConnex initiative, the opportunity to 'lock-in' improved public transport and so 'lock-out' large volumes of commuter private car use will be available only in the very short-term. To delay will risk diminishing, possibly to the extent of totally jeopardising, the transformation of Parramatta Road. That is, latent traffic demand (a well-proved phenomenon) will be unleashed and serve to perpetuate the current catch-22 of reactively responding with a 'predict and provide' approach resulting in the provision of yet more road capacity.

Indeed it is apparent, notwithstanding the stated prime purpose of WestConnex is to remove traffic from Parramatta Road so enabling its transformation, that it is the intention of the NSW Government through its Agencies to persist with Parramatta Road as a major conduit to cater for large volumes of commuter private car use. This, together with a rebadging of the existing bus service portrayed as a Bus Rapid Transit, will in effect be a 'business as usual' scenario – so stifling transformation.

The opportunity for a partnered approach, with the State, whereby Councils contribute through the planning process would promote transparency and achievement of the optimum outcome for communities and businesses. It is the realisation of the transformation vision for Parramatta Road (the nominated precincts and frame areas) that is at risk.

[37] NSW Government announcement of final version of the *Parramatta Road Corridor Urban Transformation Strategy*: http://www.aeol.com.au/databases/news/16/11/nswgov_parramatta_road_urban_corridor.html

It is imperative for Councils to engage ‘now’ and work with the NSW State Government to achieve a world’s best practice transit solution which will act as a catalyst for the transformation of the Parramatta Road Corridor.

# REFERENCES

Note: References are identified throughout the text and associated Tables and Figures. The more generally applicable references used for the Annexure are listed below.


Bodhi Alliance & EDAB Consulting; *Parramatta Road Light Rail Opportunities Study*; December 2016

Bus Industry Confederation (BIC) of Australia; *Rapid Transit - Investing in Australia's Transport Future; prepared for Australia Infrastructure*; March 2014

Institute for Transportation and Development Policy (ITDP); *International Standard for BRT & Scorecard*; 21 July 2016
https://www.itdp.org/library/standards-and-guides/the-bus-rapid-transit-standard/

NSW Government; *Parramatta Road to become a vibrant urban corridor*; Media Release; 16 November 2016
http://www.aeol.com.au/databases/news/16/11/nswgov_parramatta_road_urban_corridor.html

SGS Economic; *WestConnex Business Case Review Final Report*; City of Sydney; February 2016

Transport & Infrastructure Council (Commonwealth of Australia); *Australian Transport Assessment and Planning (ATAP) Guidelines*; August 2016

Transport for NSW (NSW Government); *Sydney's Bus Future*; December 2013

Transport for NSW (NSW Government); *Sydney CBD to Parramatta Strategic Transport Plan*; September 2015

Transport for NSW (NSW Government); *Bus Priority Program*; 24 October 2016
http://www.transport.nsw.gov.au/projects/bus-priority-program

Urban Growth NSW (NSW Government); *Parramatta Road Urban Transformation Strategy (and supporting documents), Final Version*; 9 November 2016

Urban Growth (NSW Government); *Parramatta Road Urban Transformation Program*; November 2016
http://www.urbangrowth.nsw.gov.au/projects/parramatta-road/

Urban Growth NSW (NSW Government); *Parramatta Road Urban Transformation Strategy Precinct Transport Report Reference Report*; November 2016

Urban Growth NSW (NSW Government); *Parramatta Road Urban Transformation Strategy, Sustainability Implementation Plan*; November 2016

WestConnex; *Updated Strategic Business Case, Technical Paper 1 Traffic Report*; 2016.

# APPENDIX A: BRT Compendium

## Appendix B: ITDP Standard (for Bus Rapid Transit)

# Vehicle Catalog
# A Compendium of Vehicles and Powertrain Systems for Bus Rapid Transit Service
# 2006 Update


Summer 2006

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# Table of Contents

# Foreword

This report represents one part of an effort to provide information to the U.S. transit authorities on activities related to Bus Rapid Transit (BRT). This document is prepared in partnership with the Federal Transit Administration as part of a “BRT Tool Box” which is designed to assist transit planners, management planning organizations and local transit stakeholders with readily-available, pertinent information about vehicles for use in BRT implementations. This information can aid in conceptual decision-making and communication to the community about features that encourage the use of cleaner, lower-emission vehicles.

# Notice

# Preface

This report was prepared by Weststart-CALSTART. Weststart-CALSTART is a non-profit organization that works with the public and private sectors to develop advanced transportation technologies and foster companies that will help clean the air, lessen our dependence on foreign oil, reduce global warming, and create jobs. CALSTART, Inc. is the California operating division of Weststart-CALSTART. The data contained in this report includes public information and/or information provided by other organizations. Website and contact information is provided with each description as a source of more detailed information.

# Acknowledgements

The Federal Transit Administration (FTA), Office of Mobility Innovation, sponsored the effort to compile data for this report. CALSTART would like to acknowledge the contributions in time and data from original equipment manufacturers and suppliers that made this report possible.

# About This Document

WestStart-CALSTART, in partnership with the Federal Transit Administration (FTA), is playing a vital role in the mainstreaming of Bus Rapid Transit (BRT) in the United States with a strong focus on new vehicle concepts, vehicle development strategies, and vehicles that are cleaner, quieter, and more fuel-efficient. The intent of this document is to disseminate information on currently available clean transportation bus transit vehicles and their drive systems for potential use in BRT service. This updated report was developed with the knowledge and assistance of the FTA, manufacturers and suppliers.

**Vehicles.** The vehicle section of this document contains summary information about vehicles offered for BRT service by various bus manufacturers, both U.S. and foreign. The vehicles are organized by a convention developed in another FTA document, “Characteristics of Bus Rapid Transit for Decision Making” (FTA-VA-26-7222-2004.1, August 2004). That report provides the latest information about each of the six BRT elements, including buses, their costs, and their potential impact on ridership, capacity, system performance, safety, security, and image. The CBRT describes the buses for BRT service in the following categories of 1) conventional standard, 2) stylized standard, 3) conventional articulated, 4) stylized articulated and 5) specialized BRT vehicles.

This convention focuses on the exterior image and interior amenities that make the vehicles suitable for BRT service. The same convention is used to organize the vehicle information in this document, with the addition of two more section on drivetrains (see below). The vehicle section has five subsections (standard, stylized standard, articulated, stylized articulated and specialized BRT vehicles) with vehicles in ascending order of length and manufacturers name.

One page is presented for each vehicle providing an overview of key performance parameters, features that are important to BRT service implementations and transit applications or customers. Company web site and contact links are also provided as a convenient research tool or to request additional information directly from the various organizations.

This document represents a sampling of the vehicles offered for BRT service. As a result, not all manufacturers and not all vehicles in BRT service applications are found here. The information contained here is gathered from manufacturers and/or public sources. The absence of a specific vehicle description may be a result of insufficient information at the time of publication or a specific request by the manufacturer to exclude a vehicle in this sample. Conversely, the presence of a description is merely to inform and convey information and is not meant as an endorsement by Weststart-CALSTART or the FTA. From time-to-time, this document may be revised to add more vehicles or to update information as it is made public.

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**Drive Systems.** Additionally, there are two drive system sections in this document update to highlight the clean fuel propulsion system options that are now showing up in bus manufacturer offerings. The first is focused on hybrid propulsion systems, and the second on natural gas engines. Pricing information for these systems are typically available from the bus manufacturers. This is just a sample, based on supplier inputs and will be revised from time to time to reflect the state of the industry.

# General Information about BRT

Federal Transit Administration vision for Bus Rapid Transit (BRT) Service reflects the FTA desire to "change America's mind about transit." An important ingredient of this change is making transit a more desirable choice in American communities. The FTA strives toward a public transit goal of increasing transit ridership. Its successes to date shows that BRT can share a significant place in public transit overall. The bus vehicles are an important element of BRT in promoting public transportation system improvements, realizing economic and environmental benefits.

Local communities must ultimately decide which BRT components meet their needs. Well-organized bus routes and good land use planning are important and go hand-in-hand. Reducing actual and perceived travel time by transit is an essential element in attracting new riders, along with clear customer information, easy and safe access to stops, as well as clean and comfortable places to wait for transit. Having service that is both frequent and reliable throughout the day means reduced waiting times, which makes short trips by transit more attractive.

Many American Communities deploying Bus Rapid Transit (BRT) are endeavoring to raise the level, the quality, and the image of the bus. As a result, the bus design, appearance, and amenities are changing. The information contained in this document provides a sampling of the vehicles designs that are being deployed worldwide for BRT service applications.

As BRT allows us to rethink the transit system, it also allows us to rethink the bus. BRT buses with low-emission fuel-efficient powertrains can be cleaner and quieter, offering lower costs for increased service and more neighborhood flexibility. This compendium endeavors to feature buses that can meet this promise. If you would like to comment on the contents of this document or provide new vehicle information, please send an email to Fred Silver at fsilver@weststart.org.

# 1.0 Conventional Standard Vehicles

## 40 Foot Standard — NABI 40 LFW

***Step low-floor bus with standard transit configuration body and amenities, 35' available***

**Dimensions**

| | |
|---|---|
| Length | 40 ft |
| Width | 102 in |
| Height | 116 in |

**Curb Weight**

28,500 lbs

**Price**

$300,000 to $340,000

**Capacity, Floor and Doors**

- Seats – 40 transit and suburban configurations available
- Standees – 30
- Front or rear door wheelchair ramp
- Two wheelchair positions
- Low floor entry/exit at all doors

**Comfort Items and Amenities**

- Interior/exterior noise 75/79 dBA
- Electronic climate control
- Windows – Non-opening bottom, top ventilation opening

**Electronics Options**

- GPS, AVL
- Automatic Passenger Counting
- Destination Signs
- Voice Messaging
- Video Surveillance
- Onboard Diagnostics
- Vehicle Monitoring
- Transit Signal Priority

**Propulsion and Fuel**

- Diesel — DDC, Caterpillar
- Natural Gas — Cummins

| Fuel | Economy | Storage |
|---|---|---|
| ULSD | 3.3 – 3.5 mpg | 125 gal |
| CNG | – | 8 roof tanks |
| LNG | 0.68–1.27 mi/lb | 2 rear tanks |

**Construction**

- Electrically-welded integral monocoque construction
- Mild or stainless steel structure with bonded FRP sheet roof
- Stainless steel side skins and non-hinged skirt panels

**Customers**

- Los Angeles County MTA – Metro Rapid BRT Network

**Website: www.nabiusa.com** **Contact: bussales@nabiusa.com**

*Revised: June, 2006*

## 40 Foot Standard — Orion VII

*Step low-floor bus with transit configuration body, amenities, hybrid-electric or CNG*

**Dimensions**

| | |
|---|---|
| Length | 40 ft |
| Width | 101.8 in |
| Height | 132 in, 135 in |
| | Hybrid, CNG |

**Curb Weight**

30,500 lbs

**Price**

$525,000 to $550,000 Hybrid

$325,000 to $350,000 CNG

**Capacity, Floor and Doors**

- Seats – 44 (or 37 with two wheelchair positions)
- Standees – 34
- Front or rear door wheelchair ramp
- Low floor entry/exit at all doors

**Comfort Items and Amenities**

- APTA spec Interior/Exterior Noise
- Thermo King/Carrier HVAC
- Red Dot front heater/defroster
- Windows – Opening with Pillar Covers
- Optional overhead luggage storage
- Vacuum/Thermal Formed Panel Trim
- Full Air Ride

**Electronics Options**

- GPS, AVL
- Automatic Passenger Counting
- Destination Signs – LED
- Voice/Visual Messaging
- Video Surveillance
- Onboard Diagnostics
- Vehicle Monitoring
- LED Exterior Lighting – standard
- I/O Multiplexed electrical system – standard

**Propulsion and Fuel**

- Hybrid: Cummins ISB 5.9L
  BAE Systems Hybridrive™
  Genset & AC Traction Motor
- Natural Gas: Cummins C8.3 G
  Deere 6081

| Fuel | Storage |
|---|---|
| ULSD | 100 gal |
| CNG | up to 8 SCI tanks, 22000 SCF |

**Construction**

- Integral Construction
- Mild or stainless steel structure
- Aluminum or fiberglass skins, exterior rub rails

**Customers**

- Hybrid – San Francisco MUNI; Toronto TTC; NYC MTA
- CNG – Numerous Locations in U.S.

Website: www.orionbus.com — Contact: sales@orionbus.com

*Revised: July, 2006*

# 2.0 Stylized Standard Vehicles

## 40 Foot Stylized — New Flyer Invero D40i

***Advanced features with panoramic windows, comfortable ride, and passenger amenities***


**Dimensions**

Length 41 ft
Width 102 in
Height 126 in
(with rear mount HVAC)

**Curb Weight**

27,600 lbs

**Price**

Call for Quote

**Capacity, Floor & Doors**

- Seats – 44 (90% forward facing)
- Perimeter seating available
- Standees – 46
- Patented 2 stage wheelchair ramp
- Low floor at all doors, step rear
- Plug Slide Front and Rear Doors

**Comfort Items and Amenities**

- Interior/exterior noise to 70 dBA
- AC, warm wall and floor heat
- 4 way panoramic windows
- Patented interior lighting system
- Commuter-style, high-back seats
- Luggage Accommodations

**Electronics Options**

- GPS, AVL
- Automatic Passenger Counting
- Luminator Destination Signs
- Onboard Routing/Travel Time/Stop
- Voice Messaging
- Video Surveillance
- Onboard Diagnostics
- Vehicle Monitoring
- Transit Signal Priority
- Automatic Guidance Ready

**Propulsion and Fuel**

- Diesel (Allison)
- Diesel Hybrid-Electric (Allison)
- Gasoline Hybrid-Electric (ISE)

| Fuel | Economy | Storage |
|---|---|---|
| ULSD | 4.4 mpg | 1 floor tank |
| ULSD H-E | 5.1 mpg | 1 floor tank |
| Gas H-E | 4.5 mpg | 1 floor tank |

**Construction**

- Welded monocoque carbon steel using high tensile steel plate and tubing
- Phenolic balsa core fiberglass floor

**Customers and Applications**

- Ottawa, ON; Aspen, CO; Everett, WA

**Website: www.newflyer.com** — **Contact: buses@newflyer.com**

*Revised: June, 2006*

**40 Foot Stylized** — **New Flyer D40LF**

*Step low-floor bus with restyled front mask and rear cap available on all models*


**Dimensions**

| | |
|---|---|
| Length | 40 ft |
| Width | 102 in |
| Height | 111 in |

(with rear mount HVAC)

**Curb Weight**

27,000 lbs

**Price**

Call for Quote

**Capacity, Floor & Doors**

- Seats – 39 (70% forward facing)
- Perimeter seating available
- Standees – 43
- Flip out wheelchair ramp
- Low floor at all doors, step rear
- Slide Glide Front and Rear Doors

**Comfort Items and Amenities**

- Interior/exterior noise < 70 dBA
- Air conditioning Available
- Warm wall; floor heat Available
- Interior lighting Individual
- Continuous flush-mount windows available
- Luggage accommodations

**Electronics Options**

- GPS, AVL
- Automatic Passenger Counting
- Luminator Destination Signs
- Onboard Routing/Travel Time/Stop
- Voice Messaging
- Video Surveillance
- Onboard Diagnostics
- Vehicle Monitoring
- Transit Signal Priority
- Automatic Guidance Ready

**Propulsion and Fuel**

- Diesel Allison, ZF, Voith
- Diesel Hybrid-Electric Allison
- Gasoline Hybrid-Electric ISE
- Natural Gas Cummins, DDC, JD
- Trackless Trolley Kiepe

| Fuel | Economy | Storage |
|---|---|---|
| ULSD | 4.4 mpg | 1 floor tank |
| ULSD H-E | 5.1 mpg | 1 floor tank |
| Gas H-E | 4.5 mpg | 1 floor tank |
| CNG | 3.2 mgge | 6 roof bottles |

**Construction**

- Welded monocoque carbon steel using high tensile steel plate and tubing
- Aluminum body panels; ACQ pressure preserved plywood floor

**Customers and Applications**

- TransLink – Vancouver, BC Canada
- WMATA – Washington D.C. and SEPTA

Website: www.newflyer.com — Contact: buses@newflyer.com

*Revised: June, 2006*

## 41 Foot Stylized Standard — Van Hool A330

*Full low-floor bus with European styling and a rear door for rapid boarding and alighting*


**Dimensions**

Length 40 ft 6.6 in

Width 102 in

Height 122 in

**Curb Weight**

(unavailable)

**Price**

Call for Quote

**Capacity, Floor & Doors**

- Seats – 28 (+ 4 folding seats) – forward facing
- Standees – 49, Total capacity – 81
- Flip out wheelchair ramp
- Low floor at all doors
- 3 Doors – 1 and 3 pivot in, center
- wide door opens out

**Comfort Items and Amenities**

- Electric open-assist doors, touch sensitive exterior controls
- LED Multi-color Destination Signs
- Interior route map w/super stops
- Smart Card readers, all-door boarding
- Large windows all four sides
- Door 2 Wide with wheel chair access (ramp less than 2° all curb heights)
- Large, open standing areas improves passenger circulation

**Electronics Options**

- GPS, AVL, Location ID
- Proof of payment card readers
- Multi-color Head Signs
- Public Address Messaging
- Traffic Light Controller
- LCD Dashboards with integrated diagnostics, multiplex electronics

**Propulsion and Fuel**

- Cummins ISL 280 bhp, ZF Rear Axle with offset, Voith D8643 transmission and integrated retarder

| Fuel | Economy | Storage |
|---|---|---|
| ULSD | TBD | 92 gal floor tank |
| Hydrogen | TBD | |

**Construction**

- Electrically Welded Steel/Stainless Steel Structure
- Fiberglass-Reinforced Polyester Front/Rear
- Aircraft Aluminum Roof

**Customers and Applications**

- AC Transit – BRT – WMATA

**Website: www.vanhool.com** — **Contact: bborwege@abc-companies.com**

*Revised: June, 2006*

# 40-Foot Stylized — Nova LFS

*Low-floor with exterior graphic body and amenities*


**Dimensions**

| | |
|---|---|
| Length | 40 ft |
| Width | 102 in |
| Height | 123 in |

**Curb Weight**
27,000 lbs

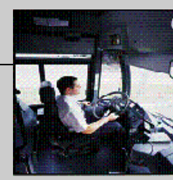
**Price**
Call for Quote

**Capacity, Floor and Doors**

- Seats – up to 49, various configurations
- Standees – 32 Capacity – 81
- Two ultra-wide doors
- Wheelchair ramps
- Low floor entry/exit at all doors
- ADA compliant

**Comfort Items and Amenities**

- Modern and attractive styling
- Spacious and efficient interior
- Comfortable seating and lighting
- Large panoramic windows
- High quality materials and finishes
- Optimal visibility through one-piece windshield with upper tinted sun-guard
- Heating and/or air conditioning
- Comes in transit, suburban and shuttle



**Electronics Options**

- Automatic passenger counter
- On-board video surveillance
- Front, side and rear destination signs
- Public Address System
- Ergonomic driver area
- Audio/video system

**Propulsion and Fuel**

- Diesel Cummins ISL 8.3 L (280/250 hp)

| Fuel | Storage |
|---|---|
| ULSD | 125 gal |

**Construction**

- Durable stainless steel structure for longer lifetime
- Body – fiber-glass outer shell
- High impact thermoplastic skirt-panels

**Customers**

- Various Canadian and American transit agencies

Website: www.novabus.com Contact: novabus.sales@volvo.com

*Revised: June, 2006*

## 42 Foot Standard — NABI 42 BRT

***BRT-stylized, composite floor and environmentally-friendly***


**Dimensions**

| | |
|---|---|
| Length | 40 ft |
| Width | 102 in |
| Height | 137 in |

**Curb Weight**

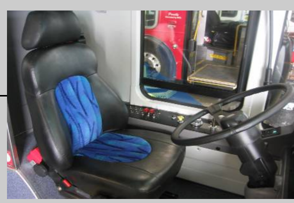
30,980 lbs

**Price**

$375,000 to $525,000

**Capacity, Floor and Doors**

- Seats – 43
- Standees – 32
- Two doors, wheelchair ramp accessible on either
- Two wheelchair positions
- Composite floor



**Comfort Items and Amenities**

- Interior/exterior – compliant with SBPG
- Electronic climate control
- Windows – Non-opening bottom, top ventilation opening
- Frameless windows, full-height door glazing, single piece front windshield.

**Electronics Options**

- GPS, AVL
- Automatic visual messaging
- Voice messaging
- Video surveillance
- Onboard diagnostics
- Vehicle monitoring
- Transit Signal Priority

**Propulsion and Fuel**

- Diesel, CNG, LNG, diesel-electric
- Caterpillar, Cummins, John Deere

| Fuel | Economy | Storage |
|---|---|---|
| ULSD | – | 125 gal |
| CNG | – | 19.748 SCF |
| LNG | – | 204 gal |

**Construction**

- Monocoque construction
- Mild steel structure with aluminum side skins
- Enclosed roof cavity conceals rooftop equipment

**Customers**

- BRT Transit Property Customers

**Website: www.nabiusa.com** **Contact: bussales@nabiusa.com**

*Revised: June, 2006*

## 40 Foot Stylized Standard — Gillig 41 BRT

*Step low-floor with transit body, amenities, plus hybrid drive economy and performance.*


**Dimensions**

| | |
|---|---|
| Length | 41 ft, 35ft, 29 ft |
| Width | 102 in |
| Height | 115 to 132 in |

**Curb Weight**

28,500 to 29,500 lbs.

**Price**

$325,000 to $525,000

**Capacity, Floor & Doors**

- 41 (seated)
- 20-30 (standing)
- Transit, perimeter, forward facing
- Ramp, restraints, signage, announcements
- Step low-floor
- Two doors (one-sided)

**Comfort Items and Amenities**

- Interior Exterior Noise Level (73.5 to 77.0/73.5 to 75.0)
- Fully automatic & environmentally friendly climate control
- LED signage

**Electronics Options**

- GPS, AVL, APC
- Video surveillance
- Onboard diagnostics
- Vehicle monitoring
- Transit Signal Priority
- Magnetic guidance in development
- Collision avoidance

**Fuel and Propulsion**

- Conventional hybrid
- Cummins (Allison) EP Hybrid Drive System
- Ultra Low Sulfur Diesel

| Fuel | Economy | Storage |
|---|---|---|
| ULSD | 4.0 mpg | 125 gal. |

**Construction**

- Modified monocoque
- Stainless steel and aluminum
- Quick change skirt panels

**Customers and Applications**

- Kansas City MAX
- Denver RTD
- LYNX (FL)
- HARTline (FL)
- Palm Trans (FL)
- TANK (KY)

**Website: www.gillig.com** — **Contacts: bmacleod@gillig.com**

*Revised: June, 2006*

# 3.0 Conventional Articulated Vehicles

# 60 Foot Conventional Articulated — NABI 60 LFW

*Step low floor high capacity bus with conventional body design and customer styled livery*


**Dimensions**

Length 60 ft
Width 102 in
Height 116 in

**Curb Weight**
42,800 lbs

**Price**
$525,000 to $725,000

**Capacity, Floor and Doors**

- Seats – 62 Standees – 31
- Total capacity – 93 passengers
- Two doors, third door optional
- Choice of door width and type
- Front or rear door wheelchair ramp
- Two wheelchair positions
- Low floor entry/exit at all doors

**Comfort Items and Amenities**

- HVAC selections available
- Electronic climate control
- Windows openable top only, bottom only, full-height or non-openable
- Stainless steel stanchion system
- Selectable seat and floor styles
- Stylized front mask
- Fluorescent Passenger Lighting

**Electronics Options**

- GPS, AVL
- Destination sign/location selection
- Automatic passenger counter
- Automatic stop announcement
- Automatic vehicle monitoring
- Conventional public address
- On-board video surveillance
- Multiplex, programmable system
- Onboard diagnostics, LED display

**Fuel and Propulsion**

- Diesel — Caterpillar, Cummins
- Natural Gas — Cummins
- Diesel Hybrid-Electric — Caterpillar, Cummins

| Fuel | Economy | Storage |
|---|---|---|
| ULSD | TBD | 125 gal |
| CNG | TBD | TBD |

**Construction**

- Structure coating: internal anti-corrosion, external epoxy
- Electrical welded stainless steel structure with stainless steel side skins and welded steel-sheet roof, FRP end caps

**Customers**

- Chicago Transit Authority – regular route service

Website: www.nabiusa.com Contact: bussales@nabiusa.com

*Revised: June, 2006*

## 60 Foot Articulated — New Flyer DE60LF

*Step low floor bus with conventional styling, diesel hybrid-electric drive and amenities*


**Dimensions**

Length 61 ft

Width 102 in

Height 132 in

(with roof mount battery pack)

**Curb Weight**

43,700 lbs

**Price**

Call for Quote

**Capacity, Floor & Doors**

- Seats - 62 (forward facing)
- Perimeter seating available
- Standees - 53
- Flip out wheelchair ramp
- Low floor at all doors, rear riser
- Up to 3 Slide and Glide Doors

**Comfort Items and Amenities**

- 5.1 mpg in revenue service
- Up to 40% better mileage than diesel alone
- 50% reduction in NOx
- 90% reduction in PM, CO, HC
- Quiet, smooth take off
- Perfect for BRT Lite applications

**Electronics Options**

- GPS, AVL
- Automatic Passenger Counting
- Luminator Destination Signs
- Onboard Routing/Travel Time/Stop
- Voice Messaging
- Video Surveillance
- Onboard Diagnostics
- Vehicle Monitoring
- Transit Signal Priority
- Automatic Guidance Ready

**Propulsion and Fuel**

- Diesel Allison, ZF, Voith
- Diesel Hybrid-Electric Allison EP50 with 330 hp CAT C9
- Gasoline Hybrid-Electric ISE

| Fuel | Economy | Storage |
|---|---|---|
| ULSD | 3.8 mpg | 1 floor tank |
| ULSD H-E | 5.1 mpg | 1 floor tank |

**Construction**

- Welded monocoque carbon steel using high tensile steel plate and tubing

**Customers and Applications**

- Seattle, WA (King County)
- Seattle, WA (Sound Transit)
- Albuquerque, NM (Albuquerque Transit)
- Honolulu, HI (The Bus)

**Website: www.newflyer.com** **Contact: buses@newflyer.com**

*Revised: June, 2006*

# 4.0 Stylized Articulated Vehicles

## 60 Foot Standard — NABI 60 BRT

*BRT-stylized, 60' low-floor articulated bus*


**Dimensions**

Length 60 ft
Width 102 in
Height 137 in

**Curb Weight**

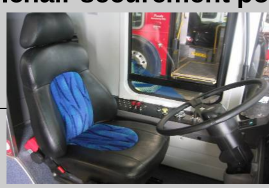
47,200 lbs

**Price**

$650,000 to $850,000

**Capacity, Floor and Doors**

- Seats - 62
- Standees - 30
- Composite, low-floor
- Low-floor entry all doors
- Wheelchair ramp in front, up to 3 wheelchair securement positions



**Comfort Items and Amenities**

- Interior/exterior – compliant with SBPG
- Electronic climate control
- Windows – bonded or clamp-in
- Frameless windows, full-height door glazing, single piece front windshield.

**Electronics Options**

- GPS, AVL
- Automatic visual messaging
- Voice messaging
- Video surveillance
- Onboard diagnostics
- Vehicle monitoring
- Transit Signal Priority

**Propulsion and Fuel**

- Diesel, CNG, LNG, diesel-electric
- Caterpillar, Cummins

| Fuel | Economy | Storage |
|---|---|---|
| ULSD | – | 125 gal |
| CNG | – | 27,000 SCF |
| LNG | – | 204 gal |

**Construction**

- Monocoque construction
- Mild steel structure with aluminum side skins
- Enclosed roof cavity conceals rooftop equipment

**Customers**

- LA Orange Line dedicated BRT route and Metro Rapid routes
- RTPA, City o Mesa, AZ
- Foothill Transit, West Covina, CA

**Website: www.nabiusa.com** **Contact: bussales@nabiusa.com**

*Revised: June, 2006*

## 60 Foot Stylized Articulated — New Flyer DE60LF-BRT

***Step low-floor bus with advanced styling, diesel electric drive and amenities***

**Dimensions**

Length 61 ft
Width 102 in
Height 136 in
(with roof mount battery pack)

**Curb Weight**
43,700 lbs

**Price**
Call for Quote

### Capacity, Floor & Doors

- Seats – 47 to 53 (75% forward facing)
- Perimeter seating available
- Standees - 53
- Flip out wheelchair ramp
- Low floor at all doors, rear riser
- 3 to 5 Slide and Glide Doors

### Comfort Items and Amenities

- 5.1 mpg fuel economy with Hybrid
- Up to 40% better mileage than diesel alone
- 50% reduction in NOx
- 90% reduction in PM, CO, HC
- Quiet, smooth take off
- Also available in 40 ft configuration

### Electronics Options

- GPS, AVL
- Automatic Passenger Counting
- Luminator Destination Signs
- Onboard Routing/Travel Time/Stop
- Voice Messaging
- Video Surveillance
- Onboard Diagnostics
- Vehicle Monitoring
- Transit Signal Priority
- Automatic Guidance Ready

### Propulsion and Fuel

- Diesel (Allison, ZF, Voith)
- Diesel Hybrid-Electric (Allison EP50 with 330 hp CAT C9)
- Gasoline Hybrid-Electric (ISE)

| Fuel | Economy | Storage |
|---|---|---|
| ULSD | 3.8 mpg | 1 floor tank |
| ULSD H-E | 5.1 mpg | 1 floor tank |

### Construction

- Welded monocoque carbon steel using high tensile steel plate and tubing

### Customers and Applications

- Lane Transit (Eugene, OR)
- Greater Cleveland RTA (Cleveland, OH)

**Website: www.newflyer.com** **Contact: buses@newflyer.com**

*Revised: June, 2006*

## 61 Foot Stylized Articulated — Van Hool AG300

***Full low-floor bus with European styling and a rear door for rapid boarding and alighting***

**Dimensions**

**Length 60 ft 6.6 in**
**Width 102 in**
**Height 134 in**

**Curb Weight**

**38,720 lbs**

**Price**

**Call for Quote**

**Capacity, Floor & Doors**

- Seats – 45 (+ 4 folding seats) – forward facing
- Standees – 57
- Flip out wheelchair ramp
- Full low floor and at all doors
- 4 Doors – 1, 3 and 4 pivot in, center wide door 2 opens out

**Comfort Items and Amenities**

- Electric open-assist doors, touch sensitive exterior controls
- LED Multi-color Destination Signs
- Interior route map w/super stops
- Smart Card readers, all-door boarding
- Large windows all four sides
- Door 2 Wide with wheel chair access (ramp less than 2° all curb heights)
- Large, open standing areas improves passenger circulation

**Electronics Options**

- GPS, AVL - Location ID
- Proof of payment card readers
- Multi-color Head Signs
- Public Address Messaging
- Traffic Light Controller
- LCD Dashboards with integrated
- diagnostics, multiplex electronics

**Fuel and Propulsion**

- ULSD — Cummins ISL 330 bhp, ZF Rear Axle with offset, Voith D864.3 transmission/integrated retarder

| Fuel | – | Economy | – | Storage |
|---|---|---|---|---|
| ULSD | – | | | 115 gal floor tank |

**Construction**

- Electrically welded/stainless steel
- Fiberglass-reinforced polyester front/rear
- Aircraft aluminum roof, galvanized walls, stainless skirts

**Customers and Applications**

- AC Transit – BRT

**Website: www.vanhool.com** — **Contact: bborwege@abc-companies.com**

*Revised: June, 2006*

# 5.0 BRT Specialized Vehicles

## 60 Foot Specialized BRT — APTS Phileas 60

***Full low-floor bus with European exterior/interior styling and magnetic guidance system***

**Dimensions**

**Length 60.5 ft**
**Width 100 in**
**Height 123 in**

**Curb Weight**

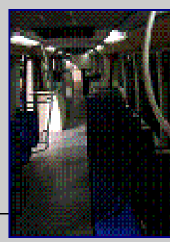
**35,300 lbs**

**Price**

**Call for Quote**

**Capacity, Floor & Doors**

- **Seats - 29 (forward facing)**
- **Standees - 111 (6 passengers/m2)**
- **Full low-floor (100%)**
- **3 doors, on one side, or 6 doors on both sides**



**Comfort Items and Amenities**

- **Futuristic and innovative styling**
- **Fully guided as tram or manually driven as bus**
- **Spacious and flexible interior (seats, doors)**
- **High quality passenger information, audible and visual systems**
- **Flexibility, large doors both sides**
- **Fully independent suspension**
- **Low interior and exterior noise levels**
- **All-wheel steering**

**Electronics Options**

- **GPS, AVL, APC, TSP, Surveillance**
- **Electronic fare payment**
- **Electronic automatic guidance until 50 mph with magnetic markers**
- **Automatic precision docking**
- **All-wheel steering**

**Fuel and Propulsion**

- **ULSD**
- **GM-Allison Parallel Hybrid–Electric Drive System**
- **Fuel economy is at least 25% greater than conventional European buses due to its hybrid element and light weight construction**

**Construction**

- **Lightweight corrosion-resistant monocoque body**
- **Lightweight modular sandwich composite**

**Customers and Applications**

- **Region of Eindhoven, Netherlands – BRT**
- **Region of Douai, France**
- **License agreement with South Korea**

**Website: www.apts-phileas.com** **Contact: apts.info@apts-phileas.com**

*Revised: June, 2006*

## 60 Foot Specialized BRT — Irisbus CIVIS

*Full low-floor bus with European exterior/ interior styling and optical guidance system*

**Dimensions**

Length 60 ft
Width 100 in
Height 134 in

**Curb Weight**

47,300 lbs

**Price**

$980,000

**Capacity, Floor & Doors**

- Seats - 27 (forward and perimeter)
- Standees - 90 (4 passengers/m2)
- Flip out wheelchair ramp
- Full low floor
- 4 wide doors, on one side


**Comfort Items and Amenities**

- Exterior noise level 83 dBA
- Large, panoramic windows on 4 sides
- Spacious interior, modern Malanite trim
- High comfort seating
- High quality passenger information, audible and visual systems
- Level board platforms at all doors
- Enclosed tubular lighting

**Electronics Options**

- GPS, AVL
- Automatic Passenger Counting
- Destination Signs
- Onboard Routing/Travel Time/Stop Visual and Voice Messaging
- Video Surveillance
- Onboard Diagnostics
- Vehicle Monitoring
- Transit Signal Priority
- Siemens Optical Guidance

**Fuel and Propulsion**

- Diesel Diesel-electric drive system

| Fuel | Economy | Storage |
|---|---|---|
| ULSD | 2.4 mpg | 125 gal tank |

**Construction**

- Stainless steel body frame
- Lightweight fiberglass body panels

**Customers and Applications**

- Las Vegas, NV – BRT

Website: www.irisbus.com — Contacts: info@irisbus.com

*Revised: 2006*

## 80 Foot Specialized BRT — APTS Phileas 80 & 85

***Full low-floor bus with European exterior/ interior styling and magnetic guidance system***

**Dimensions**

**Length 80 and 85ft**
**Width 100 in**
**Height 123 in**

**Curb Weight**

**47,600 lbs**

**Price**

**Call for quote**

**Capacity, Floor & Doors**

- **Seats – 46 to 52 (forward facing)**
- **Standees – 125-133 (6 passengers/$m^2$)**
- **Full low floor (100%)**
- **4 (one side) or 8 (two sides) doors**

**Electronics Options**

- **GPS, AVL, APC, Video surveillance**
- **Transit signal priority**
- **Electronic fare payment**
- **Electronic automatic guidance until 50 mph with magnetic markers**
- **Automatic precision docking**
- **All-wheel steering**
- **Precision docking**

**Comfort Items and Amenities**

- **Low interior and exterior noise**
- **Futuristic and innovative styling**
- **Spacious interior feel, front axle under driver and rear axle under the motor**
- **High quality passenger information, audible and visual systems**
- **Flexibility, large doors both sides**
- **Fully independent suspension**

**Fuel and Propulsion**

- **ULSD**
- **Allison Parallel Hybrid-Electric**
- **Fuel economy is at least 25% greater than comparable European vehicles due to hybrid system and light weight body.**

**Construction**

- **Lightweight corrosion-resistant monocoque body**

**Customers and Applications**

- **Region of Eindhoven, Netherlands – BRT**
- **Region of Douai, France**
- **License agreement with South Korea**

**Website: www.apts-phileas.com** **Contact: apts.info@apts-phileas.com**

*Revised: June, 2006*

## 62 Ft Stylized Articulated — Wrightbus StreetCar RTV

***Hybrid diesel-electric, multiple door-loading vehicle that creates a "wow" feeling***

**Dimensions**

| | |
|---|---|
| Length | 61.5 ft |
| Width | 99 in |
| Height | 129 in |

**Curb Weight**

30,500 lbs

**Price**

$950,000 – 1,250,000

**Capacity, Floor and Doors**

- Seats - 45
- Flat floor
- 3 doors curb side, possible door locations on roadside
- 13 ½" floor height at doors

**Comfort Items and Amenities**

- Ergonomic driver's interior
- Tinted, double-glazed windows
- LED lighting

**Electronics Options**

- Traffic signal priority
- On-board fare machinery
- AVL & CCTV

**Propulsion and Fuel**

- Hybrid diesel-electric
- ISE
- Cummins ISL engine

**Fuel** **Storage**

- TBD

| | |
|---|---|
| **Construction** | • Bolted aluminum system<br>• Modular construction |
| **Customers** | • RTC Las Vegas |

**Website: www.the-wright-group.com** **Contact: info@wright-bus.com**

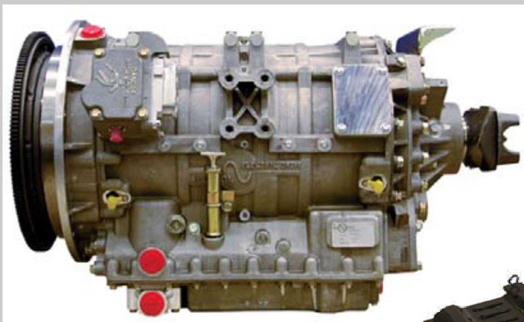
*Revised: June, 2006*

# 6.0 Hybrid Propulsion Systems

## Allison Electric Drives — Allison E$^{P}$ System

*Six-component bus hybrid-electric drive improves performance, fuel economy, emissions*

E$^{V}$ Drive Unit
Weight 944 lbs (wet)



System Controllers
Weight 3.4 lbs each

Dual Power Inverter Module
Weight 165

Energy Storage Unit
Weight 963 lbs

Total System Weight
2080 lbs

Range Selector
Push Buttons

### Performance

- 28% gradeability
- Accelerate 35,000 lb 40 ft urban bus to 30 mph in 11 seconds compared to 23 seconds for a diesel powered bus
- Top speed governed to 65 mph

### Operating Characteristics

- Parallel Hybrid-Electric drive system
- E$^{V}$ Drive Unit blends power from two motor/generators and thermal engine
- Controllers process system and driver inputs to command propulsion
- DPIM conditions and controls electrical energy for transfer/storage between the Energy Storage (ESS) and E$^{V}$ Drive Unit

### Applications and Fuel Economy

- 40 ft Transit & 60 ft articulated buses
- Suburban coaches
- 460 units in service
- 5.5 mpg on CBD-14 duty cycle

### Emissions

- CBD-14 cycle emission test with DPF
- ULSD compare to conventional diesel
- Further NOx & PM emission reductions realized with Allison E$^{P}$ System with any Clean Fuel Engine

### Customers and Applications

- Houston, TX (MTA Harris Cty)
- St. Paul, MN (Metro)
- Newark, NJ (NJT)
- Hartford, CT (CT Transit)
- Salt Lake City, UT (UTA)
- Austin, TX (Capital Metro)
- Seattle, WA (King County)
- Seattle, WA (Sound Transit)
- Orange County, CA (OCTA)
- Portland, OR (Tri-Met)
- Philadelphia, PA (SEPTA)
- Norwalk, CA (Norwalk)

Website: www.allisontransmission.com    Contact: David Mikoryak 317-242-318

*Revised: June, 2006*

## BAE Systems — HybriDrive® propulsion system

***Hybrid-electric system that improves performance, fuel economy, and emissions***

**Traction Motor**
**Weight 450 lbs**

**Hybrid Series Operation**

- Control system module directs power flow based on driver/system inputs
- Engine, controlled by the HybriDrive® system, drives the generator
- Generator supplies electricity to the traction motor and recharges the traction battery system
- Traction battery system stores energy and supplies power for acceleration
- Traction motor drives the wheels and acts as a generator to return deceleration energy that recharges the batteries

**Generator**
**Weight 275 lbs**

**Traction Battery System**
**Weight 3950 lbs**

**Control System Module**
**Weight 215 lbs**

**Performance**

- Traction Motor: 250 hp continuous/320 hp intermittent peak power
- Speed, acceleration customizable

**Operating Characteristics**

- Series hybrid-electric propulsion
- Mechanically simple, no transmission
- Cummins 5.9 L ISB thermal engine, EPA-certified

**Applications and Fuel Economy**

- Transit buses, other heavy duty
- More than 1,000 delivered or on order
- 6.5 mpg on CBD-14 duty cycle
- ULSD
- Up to 35% greater fuel efficiency

**Emissions**

- ULSD/DPF, CBD-14 cycle, versus diesel
- NOx emissions reduced > 50%
- PM reduced by 90%
- Lowers greenhouse gas emissions

**Customers and Applications**

- Toronto Transit Commission
- MTA New York City Transit
- San Francisco MUNI

**Website: www.hybridrive.com** **Contact: BAE Systems Platform Solutions 607-770-2000**

*Revised: June, 2006*

| ISE Corporation | ThunderVolt® Hybrid TB40HG-BRT & TB60HD-BRT |
|---|---|

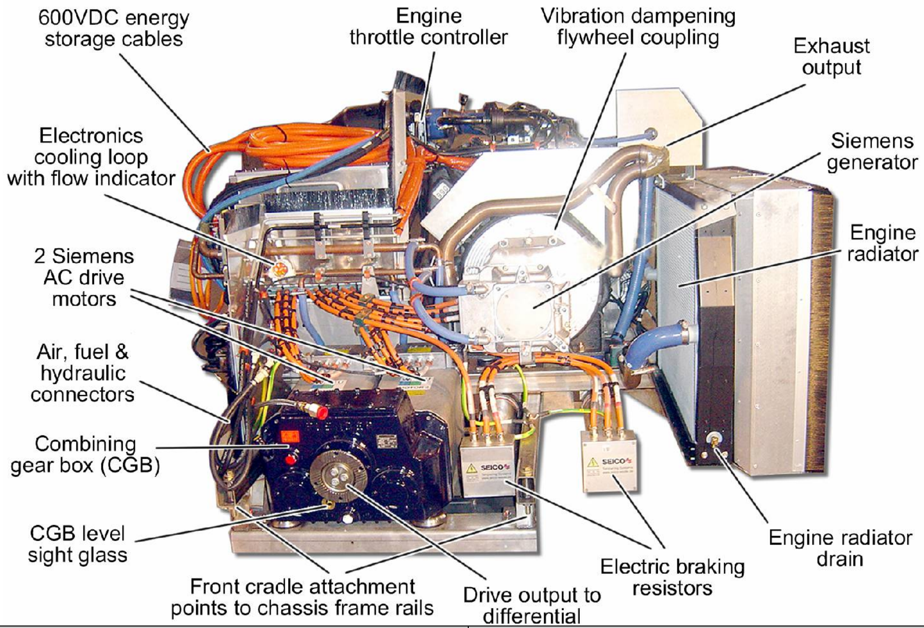
***Hybrid-electric system cradle & roof rack: improved performance, noise, fuel use, emissions***

**<u>Typical System Configuration:</u>**

**Gasoline or Diesel Hybrid Cradle (gasoline hybrid shown)**

**and**

**Rooftop Energy Storage and Cooling Systems (not shown)**




| Version | GASOLINE HYBRID<br>40-ft BRT | DIESEL HYBRID<br>60-ft BRT |
|---|---|---|
| General Characteristics | <u>Drive system type</u>: Series Hybrid<br><u>Weight</u>: 3400 - 3700 lbs<br><u>Packaging</u>: Rear engine cradle assembly and roof mounted energy storage and electronics cooling systems.<br>Ford Triton V10 with 160 $kW_{pk}$ generator. Twin Siemens drive motors.<br>Energy storage – Maxwell Ultracaps or NiMH Battery System<br>Dual 100 kW Siemens Inverters | <u>Drive system type</u>: Series Hybrid<br><u>Weight</u>: 4300 - 4900 lbs<br><u>Packaging</u>: Rear engine cradle assembly and roof mounted energy storage and cooling systems<br>▪ Cummins ISB 260H with 160 $kW_{pk}$ generator Twin Siemens drive motors.<br>▪ Energy storage – Maxwell Ultracaps or NiMH Battery System<br>▪ Dual 100 kW Siemens Inverters |
| Performance | <u>Starting Grade</u>: > 16% - <u>Top Speed</u>: rated at 65 mph - <u>Acceleration (0-30)</u>: < 20 sec. - <u>Noise Level</u>: Very quiet inside & outside, EV mode possible with battery energy storage option - <u>Low Maintenance</u>: 25-50 % less than standard drive system. | |
| | <u>Range</u>: > 300 miles (100 gallon tank)<br><u>Gasoline MPG</u>: 3.7 (Long Beach Transit service average)<br><u>Emissions</u>: NOx and NMHC at least 25% less than CARB cert (0.6 g/bhp-hr and <0.01 g/bhp-hr PM) | <u>Range</u>: > 400 miles (100 gallon tank)<br><u>MPG</u>: 4.5 mpg (New Jersey Transit average)<br><u>Emissions</u>: NOx and NMHC at least 25% less than EPA cert (2.5 g/bhp-hr, and 0.01 g/bhp-hr PM w/exhaust treatment) |
| Applications | ▪ Transit buses, trucks, trams, airport equipment, and military vehicles<br>▪ Various OEMs<br>▪ Available in 30-ft, 40-ft, and 60-ft bus models | |
| Customers | Long Beach, CA (Long Beach Transit) • Elk Grove, CA (Elk Grove e-tran) • San Bernardino, CA (Omnitrans) • Orange County, CA (OCTA) • Montebello, CA (Montebello Transit) • Norwalk, CA (Norwalk Transit) • Fresno, CA (FAX) • Los Angeles, CA (LADOT) • Gardena, CA (Gardena Municipal Bus Lines) • New Jersey, NJ (New Jersey Transit) • RTC-Las Vegas | |

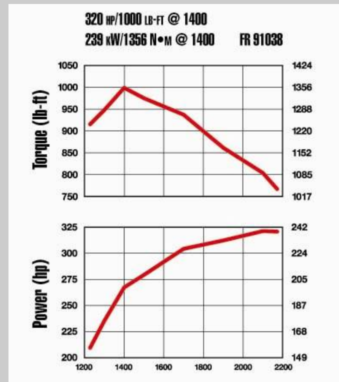
**Website: www.isecorp.com** **Contact: marketing@isecorp.com**

*Revised: July, 2006*

# 7.0 Natural Gas Engines

## Cummins-Westport — Cummins LG-320

***Cummins "Plus" technology produces better performance and longer service intervals***




### Performance

- 320 HP @ 2300 RPM
- 1000 LB-FT @ 1400 RPM
- Top speed governed to 2300 RPM
- Variable geometry turbo-charging
- Uses ECM to control fuel system, engine sensors, and ignition.

### Operating Characteristics

- CNG/LNG
- 6 cylinders
- 8.9 Liters
- 10:1 compression ratio
- 6.3-7.3 US Gallons oil system
- Spark-ignited combustion

### Applications and Fuel Economy

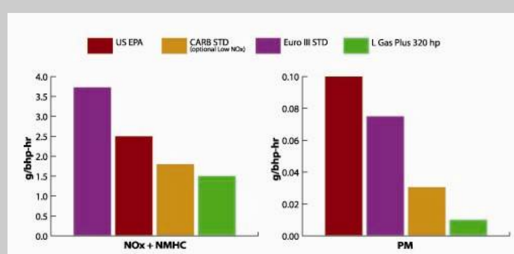
- 60 ft articulated buses, refuse trucks
- Electronic idle control
- Cummins INSITE™ and QuckCheck diagnostic service tools used for fast troubleshooting

### Emissions

- 1.4 NOx + NMHC, 0.01 PM
- Can already meet 2010 standards in 2007 with aftertreatment.
- Ultra-low emissions and low NOx:
  - U.S. EPA 2005 standard
  - U.S. EPA 2004 transit bus standard
  - CARB optional low NOx + NMHC and low PM
  - Euro V/EEV capable

### Customers and Applications

- NABI
- Los Angeles County MTA

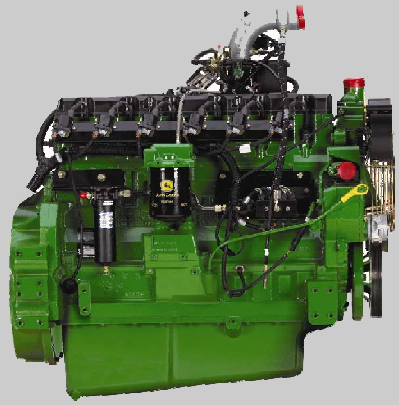



**Website: http://www.cumminswestport.com** — **Contact: Jeff Campbell 604-718-2099**

*Revised: June, 2006*

## John Deere Power Systems — 6081HFN04 Natural Gas Engine

***Turbocharged spark-ignited combustion system with programmable electronic features***



### Performance

- 250, 275, and 280 HP @ 2200 rpm;
- 735, 800, and 900 LB-FT @ 1500 rpm
- 750 rpm low idle speed
- Superior torque rise offers quick response and acceleration

### Operating Characteristics

- 6 cylinders, 8.1 Liters
- CNG/LNG capable
- 11:1 compression ratio
- Wastegate turbocharger
- Lean burn, Closed Loop Adaptive Learn Technology
- Robust construction contributes to long engine life while providing durability and reliability

### Applications and Fuel Economy

- School bus, transit bus, and refuse truck applications
- Diesel-like fuel economy

### Emissions

- CARB optional low 1.2 g/bhp-hr NOx + NMHC
- CARB/EPA certified for 50 states

### Customers and Applications

- El Dorado
- Orion Bus
- New Flyer
- Blue Bird
- Thomas Bus
- Crane Carrier
- NABI
- Millennium Bus

**Website: www.JohnDeere.com/altfuels** **Contact: Susie Patterson 319-292-5146**

*Revised: June, 2006*

# THE BRT STANDARD

**The BRT Standard**
**2016 Edition**

Cover Photo: The Rainbow BRT system in Pune/Pimpri-Chinchwad, India has transformed the city.

Cover Photo Credit: ITDP-India


www.itdp.org

www.rockefellerfoundation.org

www.barrfoundation.org

www.climateworks.org

www.despacio.org

www.giz.de

www.theicct.org

www.unhabitat.org

www.unep.org

www.wri.org


The Yichang BRT corridor uses innovative passing lanes to move over 100,000 people per day while using 20% less street width than traditional passing lanes.

# INTRODUCTION

# Introduction

**Bus rapid transit (BRT) is a bus-based rapid transit system that can achieve high capacity, speed, and service quality at relatively low cost by combining segregated bus lanes that are typically median aligned with off-board fare collection, level boarding, bus priority at intersections, and other quality-of-service elements (such as information technology and strong branding).**

The *BRT Standard* is an evaluation tool for BRT corridors based on international best practices. It is also the centerpiece of a global effort by leaders in bus rapid transit design to establish a common definition of BRT and to ensure that BRT corridors more uniformly deliver world-class passenger experiences, significant economic benefits, and positive environmental impacts.

The *Standard* functions as a planning tool, a scoring system, and a means of achieving a common definition of BRT. By defining the essential elements of BRT, it provides a framework for system designers, decision makers, and the sustainable-transport community to identify and implement high-quality BRT corridors. The *BRT Standard* celebrates cities that are leading the way in BRT excellence and offers best practice-based guidance to those planning a system.

Certifying a BRT corridor as basic BRT, bronze, silver, or gold places it within the hierarchy of international best practices. Cities with certified BRT corridors are beacons of progress that have adopted a cutting-edge form of mass transit, elevating urban transport to a new level of excellence while making communities more livable, competitive, and sustainable. The elements that receive points in the *BRT Standard* have been evaluated by BRT experts in a wide variety of contexts. When present, these elements result in consistently improved system performance and have a positive impact on ridership. Being certified as gold or silver, however, does not necessarily imply that a corridor is costly or complicated, since many BRT features are low cost or even no cost. Even relatively simple systems can achieve a high score if care is given to design decisions. From Belo Horizonte, Brazil, to Yichang, China, cities that have built gold-standard BRT have seen significant benefits to commuters, revitalized city centers, and better air quality.

As we continue to clarify and elevate the standards to which all BRT corridors are built, more people will experience the convenience and comfort of this cutting-edge mode of transport, and more cities will reap the benefits of an efficient and cost-effective mass-transit system. We hope that helping define and recognize good-quality BRT will bring about the fundamental change needed to shift people out of their cars through modern and sustainable BRT. To better meet this goal, the 2016 *Standard* has an increased focus on operations and safety, to ensure that corridors ranked highly using the BRT Standard continue to deliver high-quality service to passengers.

# Glossary

The following terms are important to understanding BRT:

### Active Bus Control

A bus operations system that uses data from automatic vehicle location (AVL) systems, which are based on global positioning system (GPS) information, to allow for bus service adjustments to be made in real time, often through an automated process;

### Arterial Street

A major transportation thoroughfare designed for longer distance trips within a city;

### Busway Alignment

The location of transit lanes within the right-of-way on a street;

### BRT Corridor

A section of road or contiguous roads served by a bus route or multiple bus routes with a minimum length of 3 kilometers (1.9 miles) that has dedicated bus lanes and otherwise meets the BRT basic minimum requirements;

### Direct Service

A BRT service pattern where multiple bus routes operate in a BRT corridor busway as well as outside the BRT corridor. This allows passengers to make trips with fewer transfers than with conventional trunk and feeder services;

### Frequency

The number of buses that arrive in a given length of time on a single bus route or on a street segment (including multiple routes). For the purpose of the BRT Standard, the deductions for low frequencies (large headways) are measured by bus route—for example, on the TransOeste corridor in Rio de Janeiro, Brazil, the frequency for buses on the Expressas (express) routes is around 30 buses per hour;

### Grade-Separated

When a transportation corridor is designed so that users do not cross direct paths of users on the corridors that it crosses. Grade separation is achieved by separating transportation corridors vertically. A flyover and an underground metro are two examples of grade separation;

### Headway

The length of time between buses either on a single bus route or on a street segment (including multiple routes). For the purpose of the BRT Standard, the deductions for low frequencies (large headways) are measured by bus route—for example, on the TransOeste corridor in Rio de Janeiro, Brazil, the average headway for the Expressas (express) buses is two minutes, meaning that buses on that route arrive every two minutes;

### Right-of-Way

The width of public space dedicated to the movement of people and goods as well as other public uses;

### Spur

A stretch of BRT infrastructure that branches off a BRT corridor but is not long enough to be considered a corridor by itself, as it is less than 3 kilometers (1.9 miles) in length;

### Trunk and Feeder Service

A BRT service pattern where all BRT bus routes operate only along the BRT corridor (the trunk route) and feeder bus routes take people to and from BRT stations. Passengers must transfer between feeder routes and BRT trunk routes.

# Why was the BRT Standard Created?

The *BRT Standard* was developed to create a common definition of bus rapid transit and to recognize high-quality BRT corridors around the world. It also functions as a technical tool to guide and encourage municipalities to consider the key features of the best BRT corridors as they move through the design process.

Despite the increasing prevalence, prominence, and success of BRT, many remain unaware of the characteristics of the best BRT corridors and their ability to provide levels of service more typically associated with metro and subway systems. Prior to the introduction of the *BRT Standard* there was no common understanding of what constitutes BRT, which caused confusion about the concept. While new world-class BRT corridors continue to be implemented, the lack of quality control has often led to modest bus corridor improvements being branded as BRT or key BRT components of planned corridors being omitted due to financial or political concerns. This has frequently resulted in a preference for rail where BRT would be a comparable, more cost-effective, and equally elegant solution. The *Standard* seeks to remedy this issue by creating a common definition of BRT and its key features, and an improved understanding of the resulting level of capacity, speed, and service quality from the features that are included.

BRT also plays an important role in the global effort to reduce transport-sector emissions. As emissions from private motor vehicle use grow, shifting these trips onto public transit and avoiding new motor vehicle trips can be achieved by improving the quality and reach of BRT. Establishing a quality standard for BRT not only ensures that better projects are built but that transport sector emissions are reduced. Each transit investment, however, must be planned and designed based on the specific conditions that frame the investment, and BRT may not be the best solution in all instances. More detailed guidance on the design and planning of BRT Corridors can be found in the BRT Planning Guide.

# What's New in 2016?

The *BRT Standard*, 2016 edition, is the product of feedback received from BRT practitioners around the world. Suggestions were formulated into concrete proposals, which were considered by the *BRT Standard* Technical Committee, a group consisting of leading BRT engineers, designers, and planners. Descriptions of the most significant changes follow:

- **Focus on Safety**
  To better address safety concerns, the Pedestrian Access section has been renamed Pedestrian Access and Safety and now requires more safety features, such as safe and frequent pedestrian crossings in built-up areas. In addition, new operations deductions have been added, including a deduction for excessive pedestrian wait times and poor maintenance of pedestrian and bicycle facilities;

- **Increased Focus on Operations**
  To encourage high-quality system operations, new operations deduction elements have been added for numerous issues that have been encountered on BRT corridors, which significantly degrade corridor quality, even on corridors with excellent design. These include deductions for bus bunching, permitting unsafe bicycle use, lack of traffic safety data, and buses running parallel to the BRT corridor;

- **Separate Design Score and Full Score (Design + Operations) Options**
  A separate Design Score is now allowed for assessing the design elements of an operational BRT corridor, indicating the potential performance. This can be assessed when a corridor launches. The Full Score (Design + Operations), combining the Design Score and operations deductions, can be assessed six months after commercial operations have begun, allowing usage and operations to stabilize. This provides a full indication of performance based on both design and operations;

- **Improved Dedicated Right-of-Way Definition**
  The dedicated right-of-way element has been modified to create a simpler and more effective means of assessing exclusive bus lanes. More emphasis has been placed on physical separation, which reduces the need for enforcement;

- **New Busway Alignments**
  The busway alignments element has been expanded to include 4 points (out of 8) for two types of alignments that are increasingly common; both alignments are for busways on boulevard-type streets with both a central/express roadway and service roads on the sides separated by a median;

- **Onboard Fare Validation**
  The BRT Standard now allocates some points for onboard fare validation of tickets purchased off-board. This type of system is in use in many cities in Europe and is being implemented in lower-demand corridors in North America as well. It can provide significant time savings when combined with all-door boarding.

**Park-and-Ride Lots**

**Many transit experts have requested the addition of points for park-and-ride facilities in the *Standard* to increase ridership in low-demand areas. While these facilities can attract additional ridership, they occupy land with high transit-oriented development (TOD) potential, compete with bus and nonmotorized transportation access options, and encourage autocentric development farther from the corridor. Given this, the Technical Committee has decided not to include park-and-ride lots in the *Standard*.**

# Governance

Two committees govern the *BRT Standard*: the Technical Committee and the Institutional Endorsers. The Institute for Transportation and Development Policy (ITDP) currently convenes both committees.

The Technical Committee of the *BRT Standard* is composed of globally renowned experts on BRT. This committee serves as a consistent source of sound technical advice with respect to BRT and is the basis for establishing the credibility of the *BRT Standard*. The Technical Committee certifies corridors and recommends revisions to the *BRT Standard* as needed.

**The *BRT Standard* Technical Committee members include:**

Manfred Breithaupt, *Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)*

Paulo Custodio, *Consultant*

Darío Hidalgo, *World Resources Institute Ross Center for Sustainable Cities*

Walter Hook, *BRT Planning International*

Wagner Colombini Martins, *Logit Consultoria*

Gerhard Menckhoff, *World Bank (retired)**

Juan Carlos Muñoz, *Bus Rapid Transit Centre of Excellence, Pontificia Universidad Católica de Chile*

Ulises Navarro, *ITDP*

Carlosfelipe Pardo, *Despacio*

Scott Rutherford, *University of Washington**

Pedro Szasz, *Consultant*

Lloyd Wright, *Asian Development Bank**

Unless indicated by an asterisk (*), each committee member also represents his or her institution.

**In Memorium: Colleen McCaul**

**It is with great sadness that we said goodbye to Colleen McCaul, who died in early 2016. Colleen contributed to this latest version of the BRT Standard, as a constructive and considerate member of the Technical Committee. She consulted in the field of transportation planning, management and research in South Africa for over 20 years, particularly on BRT and informal transport. Colleen lead the the Rea Vaya BRT design team for years, and was vital to negotiating the first Rea Vaya BRT operating contract with affected minibus-taxi operators. She authored the book *No Easy Ride*, about the minibus-taxi industry. In a field often dominated by men, Colleen brought technical integrity, a mighty mind and a generous spirit. She will be dearly missed.**

The emissions scoring detail for buses was recommended by the International Council on Clean Transportation (ICCT), a nonprofit organization specializing in vehicle efficiency and fuel standards.

The Institutional Endorsers are an integrated group of highly respected institutions in the fields of city building, public transport systems, and climate change with decision-making abilities over the *BRT Standard* certification process. All have a commitment to high-quality public transport and its impact on social and economic development.

The endorsers establish the strategic direction of the *BRT Standard*, ensure that BRT projects ranked by the scoring system uphold the goals of the *BRT Standard*, and promote the *BRT Standard* as a quality check for BRT projects globally.

**The Institutional Endorsers include:**

Barr Foundation

ClimateWorks Foundation

Despacio

Gesellschaft für Internationale Zusammenarbeit (GIZ)

Institute for Transportation and Development Policy (ITDP) (convener)

International Council on Clean Transportation (ICCT)

The Rockefeller Foundation

United Nations Environment Programme (UNEP)

United Nations Human Settlements Programme (UN-Habitat)

World Resources Institute (WRI) Ross Center for Sustainable Cities

# Updating the BRT Standard

The *BRT Standard* is reviewed and updated at least every three years by the Technical Committee. The members of the *BRT Standard* Technical Committee welcome input from other experts in the field, which they will take into consideration and raise for serious discussion if warranted. The Technical Committee debates proposed changes and tests them against known systems to gauge their accuracy.

# Overview of the BRT Standard Scorecard

The BRT Standard scoring system was created as a way of protecting the BRT brand and offering recognition to high-quality BRT corridors around the world. Certifying a BRT corridor as gold, silver, bronze, or basic sets an internationally recognized standard for the current best practices for BRT. Corridors are assessed in two ways: **Design Score** and **Full Score** (Design + Operations). The full scoring system is shown on page 25 and described in detail throughout this document.

## Design Score

The Design Score is a basic reflection of BRT corridor quality based solely on the implemented design and services. This Design Score represents the maximum potential for performance on a corridor. Points are awarded for the elements of corridor design that most significantly improve BRT speed, capacity, reliability, and quality of service.

## Full Score (Design + Operations)

Full Scores are the most complete and realistic indicator of BRT corridor quality and performance. The Full Score combines the Design Score with operations deductions, where points are subtracted from the score based on operational elements that significantly reduce corridor performance and quality of service. Full Scores (Design + Operations) may only be assessed six months after a corridor has launched commercial operations, to allow usage and operations to be more representative of longer-term patterns.

## Point System Criteria

The criteria used to determine the point system are as follows:

- The points should act as proxies for better service (speed, capacity, reliability, and comfort);
- The points should be assigned based on a general consensus among BRT experts on what constitutes best practices in BRT corridor planning, design, and operations, and the relative importance of those factors;
- The points should reward good, often politically challenging design and operational decisions made by the project team that will result in superior performance rather than rewarding characteristics that may be innate to a corridor, such as geographic location or weather;
- The metrics and weightings should be easily and equitably applicable as well as scalable to a wide range of BRT corridors in different contexts—from lower-ridership, smaller corridors to larger, high-volume corridors;
- The basis for the score should be reasonably transparent and independently verifiable without recourse to information that cannot be readily obtained.

The maximum number of points a corridor can earn is 100. An overview of the four BRT Standard point categories follows. Bronze, silver, and gold rankings all reflect well-designed corridors that have achieved excellence. A ranking of basic BRT means that the corridor meets the minimum criteria to qualify as BRT but has not quite reached the same level of excellence as those that have received bronze, silver, or gold awards.

# BRT Standard Rankings


**Gold-standard BRT**
**85 Points or above**

Gold-standard BRT is consistent in almost all respects with international best practices. These corridors achieve the highest level of operational performance and efficiency while providing a high quality of service. The gold level is achievable on any corridor with sufficient demand to justify BRT investments. These corridors have the greatest ability to inspire the public, as well as other cities.


**Silver-standard BRT**
**70–84.9 points**

Silver-standard BRT includes most of the elements of international best practices and is likely to be cost-effective on any corridor with sufficient demand to justify BRT investment. These corridors achieve high operational performance and quality of service.


**Bronze-standard BRT**
**55–69.9 points**

Bronze-standard BRT solidly meets the definition of BRT and is mostly consistent with international best practices. Bronze-standard BRT has some characteristics that elevate it above the BRT basics, achieving higher operational efficiencies or quality of service than basic BRT.

**Basic BRT**

Basic BRT refers to a core subset of elements that the Technical Committee has deemed essential to the definition of BRT. This minimum qualification is a precondition to receiving a gold, silver, or bronze ranking.

# Design versus Performance

The *BRT Standard* relies on easily observable design and operations characteristics that are associated with high performance rather than on performance measurements. This is currently the most reliable and equitable mechanism for recognizing quality in different corridors. The main reasons for this approach include:

- **The ability to assess both planned and existing corridors:** the BRT Standard is intended to help guide planning and design decisions prior to corridor implementation. The Design Score can be assessed for both planned and built corridors and allows the two to be compared, whereas performance standards are only applicable when assessing operational corridors;

- **Good data is rare and expensive:** while the effect of the BRT corridor on a passenger's door-to-door travel time would be the ideal performance appraisal metric, this data is extremely difficult, expensive, and time-consuming to collect and nearly impossible to independently corroborate.

# Other Project Appraisal Tools

The *BRT Standard* is intended to complement cost-effectiveness measurements and corridor performance evaluations. Using the *BRT Standard* without cost-effectiveness appraisal tools could lead to underspending on BRT elements that would increase operational efficiency or improve service quality. Conversely, some elements of BRT or even the choice to pursue BRT may not be justified based on a cost-effectiveness appraisal. For these reasons, the *BRT Standard* should be used in tandem with a cost-effectiveness or cost-benefit evaluation.

Similarly, the *BRT Standard* may be a useful element of project appraisal as a way of testing the credibility of claimed speed improvements or other performance claims made as part of a more systematic "performance-based" appraisal, such as the U.S. Federal Transit Administration's cost-effectiveness analysis or the internal rate-of-return analysis required by development banks during project appraisal.

# Scoring Corridors

Corridor scores are calculated based on the detailed scoring system described in the following pages. Scores are submitted to the Technical Committee and are verified by individual members of the Technical Committee. Once a score has been verified by at least one member, it may be released to the public. Ideally, more than one person will score each corridor.

Corridors are visited during rush hour, and the visit must consider the three busiest stations on the corridor. The score report will be documented with text and/or photos and may only account for elements that are in place, unless otherwise required in the Standard (e.g., the Multi-Corridor Network element). If any element for scoring a corridor requires gathering data from more than ten stations, then a random sample of at least five stations may be substituted.

A Full Score using the BRT Standard includes both the Design Score and operations deductions. Design Scores may be assessed at any time after a corridor has opened. Operations deductions may only be assessed after a corridor has been in commercial operation for at least six months. Design Scores and Full Scores are official once they have been verified by a member of the Technical Committee.

All bus transit corridors that have not previously been scored are eligible for scoring; previously scored corridors may be rescored upon request if they have experienced significant changes in design or operations since the last time they were evaluated. When a corridor is rescored, the justification for rescoring the corridor will also be noted when the new score is released.
Scores will be released each year and used as a means to compare and celebrate those cities that have made the politically courageous and technically difficult decisions necessary to implement true BRT.

The BRT Standard Technical Committee and the Institutional Endorsers look forward to making this an even stronger tool for creating better BRT corridors and encouraging better public transport that benefits cities and citizens alike.

For any questions on the scoring process, or to request a scoring, please contact brtstandard@itdp.org.


The Metroplus BRT, in Medellín, Colombia, provides a critical link in the city's diverse transit network.


# BRT AWARDS SHOWCASE


团结路
Tuanjie Rd.
请提前选择车道
Lvluo Lu
东山大道
400-659-6666
65199
A9254


# Yichang BRT

**YICHANG, CHINA**

**Ranking:** Gold

**Corridor Length:** 23km

**Riders per Day:** 240,000

**Notable Strengths:** Yichang's direct service system uses passing lanes to allow a wide rang of routes to benefit from the BRT corridor.

**Areas for Improvement:** The BRT corridor would benefit from more continuous bicycle pat bicycle parking, and the planning bike share system to improve access to stations.

# MOVE

MOVE—CRISTIANO MACHADO

**BELO HORIZONTE, BRAZIL**

**Ranking:** Gold

**Corridor Length:** 7.1 km

**Riders per Day:** 185,000

**Notable Strengths:** MOVE BRT has created very high capacity BRT corridors in areas with high demand. The BRT corridors continue into the heart of the city, where demand is the highest but space is at the greatest premium.

**Areas for Improvement:** The BRT corridor would benefit from more turn restrictions, to minimize delay at intersections. The corridor would also benefit from  mid-block crosswalks to create more direct access to stations outside of downtown.


50-EST.PAMPULHA
Mascarello
40550

# TransMilenio

SUBA

**BOGOTÁ, COLOMBIA**

**Ranking:** Gold

**Corridor Length:** 13km

**Riders per Day:** 120,000

**Notable Strengths:** Transmilenio introduced high capacity BRT to the world. It is able to move people to a degree that equals and exceeds many metro systems.

**Areas for Improvement:** Transmilenio has been so successful that it has experienced overcrowding. More frequent bus service and network expansion would help to alleviate these issues.


# Metrobus

9 DE JULIO

**BUENOS AIRES, ARGENTINA**

**Ranking:** Silver

**Corridor Length:** 3.5km

**Riders per Day:** 255,000

**Notable Strengths:** The 9 de Julio BRT corridor makes effective use of public space on one of the widest urban arterials in the world. To allow buses with right side doors to use the open corridor, buses drive on the left. Passing lanes further increase capacity along this busy corridor, quickly moving people through the heart of the city.

**Areas for Improvement:** Off-board fare collection would further improve bus speeds and reliability on the corridor. Limited stop and express services could be introduced to take better advantage of the passing lanes on the corridor.

# Metrobús

LÍNEA 3

**MEXICO CITY, MEXICO**

**Ranking:** Silver

**Corridor Length:** 17km

**Riders per Day:** 140,000

**Notable Strengths:** Located on a high-demand corridor, the Metrobús Línea 3 has high quality buses and stations, frequent service and good connections to Metro stations and the fiver other Metrobús corridors.

**Areas for Improvement:** Metrobús would benefit from fare integration with the Metro system, better intersection treatments, and better integration with the growing bicycle network.


# Rea Vaya

PHASE 1A

**JOHANNESBURG, SOUTH AFRICA**

**Ranking:** Silver

**Corridor Length:** 25km

**Riders per Day:** 42,000

**Notable Strengths:** Rea Vaya has high quality stations, and potential to easily increase capacity over time, as demand increases on the corridor. The corridor connects through the downtown.

**Areas for Improvement:** The corridor needs better maintenance of infrastructure and better enforcement of the exclusive bus lanes.

# CTfastrak

HARTFORD–NEW BRITAIN

**HARTFORD, UNITED STATES**

**Ranking:** Silver

**Corridor Length:** 9.4km

**Riders per Day:** 14,000

**Notable Strengths:** CTfastrak repurposed an unused freight rail corridor as bus rapid transit, minimizing delays at intersections. The corridor offers a direct service model, where routes operate on part or all of the corridor as well as off the corridor.

**Areas for Improvement:** The corridor would benefit from extending full BRT treatments into downtown Hartford. Wait times would be reduced by extending proof-of-payment fare collection to all routes on the corridor.

# Rainbow BRT

CORRIDOR 2: SANGAVI KIWALE

**PIMPRI-CHINCHWAD, INDIA**

**Ranking:** Bronze (design)

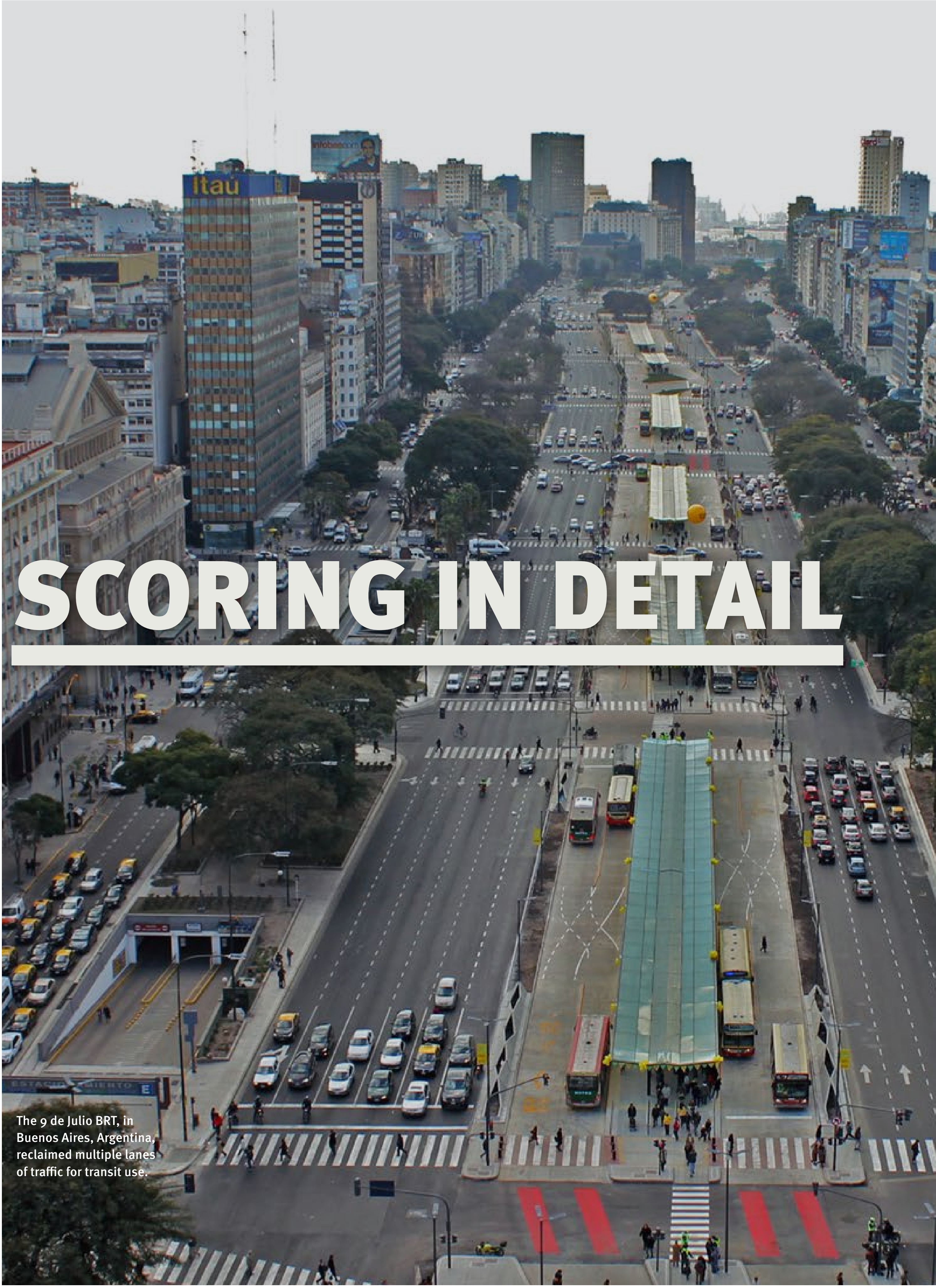
**Corridor Length:** 14km

**Riders per Day:** 120,000

**Notable Strengths:** The Rainbow BRT system introduced BRT in a challenging transportation context.

**Areas for Improvement:** Implementing off-board fare collection and better intersection priority would increase bus speeds along the corridor.

# SCORING IN DETAIL




The 9 de Julio BRT, in Buenos Aires, Argentina, reclaimed multiple lanes of traffic for transit use.

# The BRT Standard Scorecard

This scorecard shows the criteria and point values that make up the *BRT Standard*, followed by a detailed description of each.

| CATEGORY | MAX SCORE |
|---|---|
| **BRT Basics** (PP. 26–37) | **38 (TOTAL)** |
| Dedicated Right-of-Way | 8 |
| Busway Alignment | 8 |
| Off-Board Fare Collection | 8 |
| Intersection Treatments | 7 |
| Platform-level Boarding | 7 |
| **Service Planning** (PP. 38–44) | **19** |
| Multiple Routes | 4 |
| Express, Limited-Stop, and Local Service | 3 |
| Control Center | 3 |
| Located in Top Ten Corridors | 2 |
| Demand Profile | 3 |
| Hours of Operations | 2 |
| Multi-Corridor Network | 2 |
| **Infrastructure** (PP. 45–52) | **13** |
| Passing Lanes at Stations | 3 |
| Minimizing Bus Emissions | 3 |
| Stations Set Back from Intersections | 3 |
| Center Stations | 2 |
| Pavement Quality | 2 |
| **Stations** (PP. 53–57) | **10** |
| Distances Between Stations | 2 |
| Safe and Comfortable Stations | 3 |
| Number of Doors on Bus | 3 |
| Docking Bays and Sub-stops | 1 |
| Sliding Doors in BRT Stations | 1 |

| CATEGORY | MAX SCORE |
|---|---|
| **Communications** (PP. 58–59) | **5** |
| Branding | 3 |
| Passenger Information | 2 |
| **Access and Integration** (PP. 60–65) | **15** |
| Universal Access | 3 |
| Integration with Other Public Transport | 3 |
| Pedestrian Access and Safety | 4 |
| Secure Bicycle Parking | 2 |
| Bicycle Lanes | 2 |
| Bicycle-Sharing Integration | 1 |
| **Operations Deductions** (PP. 66–72) | **-63** |
| Commercial Speeds | -10 |
| Peak Passengers per Hour per Direction (pphpd) Below 1,000 | -5 |
| Lack of Enforcement of Right-of-Way | -5 |
| Significant Gap Between Bus Floor and Station Platform | -5 |
| Overcrowding | -5 |
| Poorly Maintained Infrastructure | -14 |
| Low Peak Frequency | -3 |
| Low Off-Peak Frequency | -2 |
| Permitting Unsafe Bicycle Use | -2 |
| Lack of Traffic Safety Data | -2 |
| Buses Running Parallel to BRT Corridor | -6 |
| Bus Bunching | -4 |

# Definition of a BRT Corridor

The *BRT Standard* is to be applied to specific BRT corridors rather than to a BRT system as a whole. This is because the quality of BRT in cities with multiple corridors can vary significantly. For the purposes of the *BRT Standard*, a BRT corridor is defined as:

> A section of road or contiguous roads served by a bus route or multiple bus routes with a minimum length of 3 kilometers (1.9 miles) that has dedicated bus lanes.

The primary reason for defining the corridor in this way is that in some cities BRT is not prioritized over automobile traffic, an essential element in rapid transit that improves both efficiency and cost. To avoid rewarding corridors that do not make this political choice, the corridor needs to be defined as including dedicated bus lanes.

Spurs—short sections of dedicated bus lanes that connect to a middle section of the primary bus corridor—are considered part of the primary corridor if they are less than three kilometers (1.9 miles) in length. Similar sections of dedicated bus lanes that are greater than three kilometers (1.9 miles) in length are considered separate corridors.

# The BRT Basics

The "BRT Basics" are a set of elements that the Technical Committee has deemed essential to defining a corridor as BRT. These five elements most critically contribute to eliminating sources of delay from congestion, conflicts with other vehicles, and passenger boarding and alighting, thus increasing efficiency and lowering operating costs. They are of critical importance in differentiating BRT from standard bus service. The five essential elements of BRT (and their maximum scores) are:

**Dedicated right-of-way** (8 points)
**Busway alignment** (8 points)
**Off-board fare collection** (8 points)
**Intersection treatments** (7 points)
**Platform-level boarding** (7 points)

*Of the five essential elements, a corridor must score at least 4 on both busway alignment and dedicated right-of-way **AND** must achieve a minimum of 20 points across all five categories to be identified as BRT.

# Minimum Requirements for a Corridor to Be Considered BRT

1. At least 3 kilometers (1.9 miles) in length with dedicated lanes
2. Score 4 or more points in dedicated right-of-way element
3. Score 4 or more points in busway alignment element
4. Score 20 or more total points across all five BRT basics elements

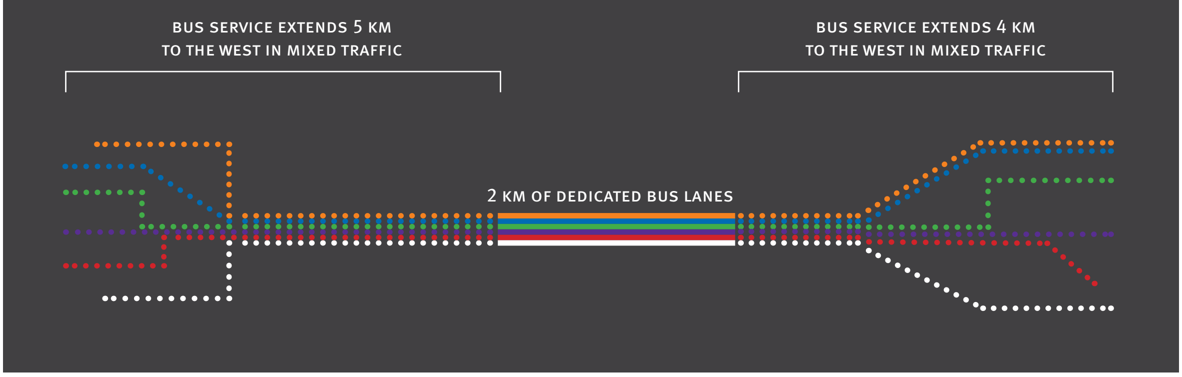
# Examples of BRT Corridors

**Note:** To qualify as BRT, a corridor must also meet the BRT Basics

## Example 1: A 3-kilometer (1.9 mile) corridor


## Example 2: A 3-kilometer (1.9 mile) corridor


## Example 3: NOT A Corridor



# Dedicated Right-of-Way

## 8 points maximum

A dedicated right-of-way is vital to ensuring that buses can move quickly and unimpeded by congestion. Physical design is critical to the self-enforcement of the right-of-way. Dedicated lanes matter the most in heavily congested areas where it is harder to take a lane away from mixed traffic to dedicate it as a busway.

Dedicated lanes can be segregated from other vehicle traffic in different ways, but physical separation typically results in the best compliance and the easiest enforcement. Physical separation includes a physical impediment to entering and exiting the lanes. Some physical barriers, such as fences, prevent vehicles from entering and exiting bus lanes entirely, while other barriers, such as curbs, can be carefully mounted to enter or exit the bus lanes. In some designs the bus stations themselves can act as barriers. Some permeability is generally advised, as buses occasionally break down and block the busway or otherwise need to leave the corridor.

While the definition of a BRT corridor requires at least 3 kilometers (1.9 miles) of dedicated bus lanes, this element evaluates the quality of the segregation throughout the corridor, including sections without dedicated lanes.

**BRT Basics:** this is an element of BRT deemed essential to true BRT corridors. A minimum score of 4 must be achieved on this element for a corridor to be defined as BRT.

**Scoring Guidelines:** the score is calculated by multiplying the percentage of the corridor that has each type of dedicated right-of-way for BRT services by the number of points associated with the type of dedication. Corridor segments that permit the use of taxis, motorcycles, high-occupancy vehicles, and other nonemergency vehicles are not considered to have dedicated lanes.

| Type of Dedicated Right-of-Way | POINTS | WEIGHTED BY |
|---|---|---|
| Physically separated, dedicated lanes | 8 | % of corridor with type of dedicated right-of-way |
| Color-differentiated, dedicated lanes with no physical separation | 6 | |
| Dedicated lanes separated by a painted line | 4 | |
| No dedicated lanes | 0 | |


The Rainbow BRT in Pune/ Pimpri-Chinchwad, India uses fences to create dedicated physically-separated bus lanes.

# Busway Alignment

## 8 points maximum

The busway is best located where conflicts with other traffic can be minimized, especially from turning movements from mixed-traffic lanes. In most cases, a busway in the central verge of a roadway encounters fewer conflicts with turning vehicles than those adjacent to the curb due to alleys, parking lots, and so forth. Additionally, while delivery vehicles and taxis generally require access to the curb, the central verge of the road usually remains free of such obstructions. All of the design configurations recommended below are related to minimizing the risk of delays caused by turning conflicts and curbside access.

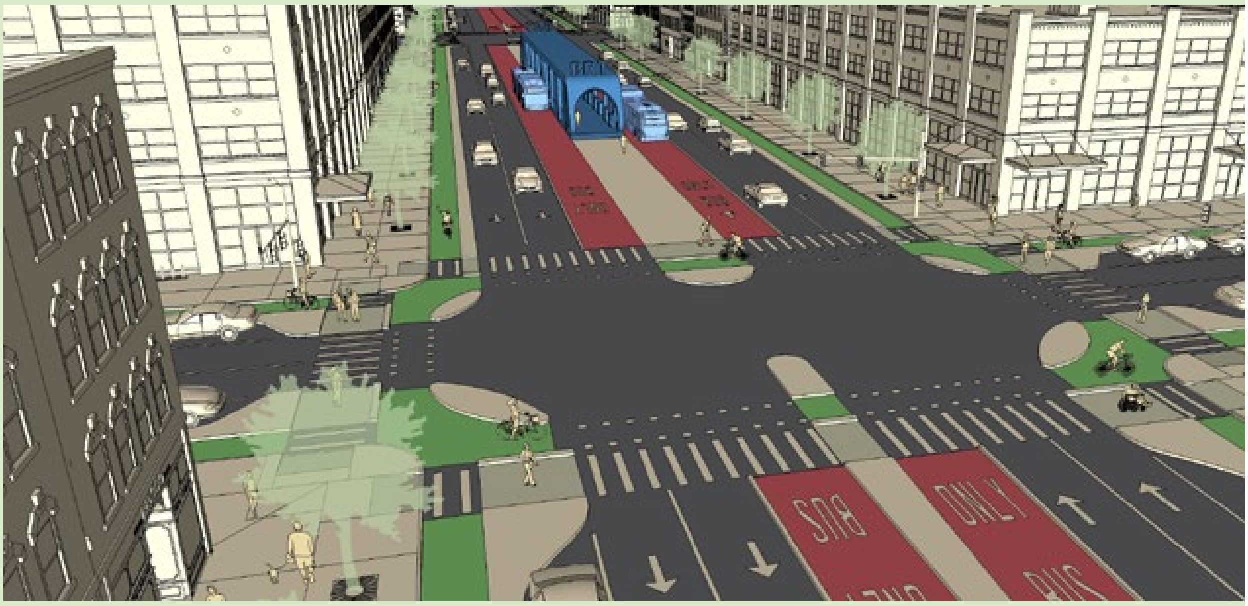
**BRT Basics:** this is an element of BRT deemed essential to true BRT corridors. A minimum score of 4 must be achieved on this element for a corridor to be defined as BRT.

**Scoring Guidelines:** this scoring is weighted using the percentage of the corridor of each particular configuration multiplied by the points associated with that configuration and then adding those numbers together.

| Corridor Configurations | POINTS | WEIGHTED BY |
|---|---|---|
| **TIER 1 CONFIGURATIONS** | | % of corridor with type of dedicated right-of-way |
| Two-way median-aligned busway in the central verge of a two-way road | 8 | |
| Bus-only corridor where there is a fully exclusive right-of-way and no parallel mixed traffic, such as a transit mall (e.g., Bogotá, Colombia; Curitiba, Brazil; and Quito, Ecuador) or a converted rail corridor (e.g., Cape Town, South Africa, and Los Angeles) | 8 | |
| Busway that runs adjacent to an edge condition like a waterfront or park where there are few intersections to cause conflicts | 8 | |
| Busway that runs two-way on the side of a one-way street | 6 | |
| **TIER 2 CONFIGURATIONS** | | |
| Busway that is split into two one-way pairs on separate streets, with each bus lane centrally aligned in the roadway | 5 | |
| Busway aligned to the outer curb of the central roadway on a street with a central roadway and parallel service road | 4 | |
| Busway aligned to the inner curb of the service road on a street with a central roadway and parallel service road. Busway must be physically separated from other traffic on the service road to receive points | 4 | |
| Busway that is split into two one-way pairs on separate streets, with each bus lane aligned to the curb | 3 | |
| **TIER 3 CONFIGURATIONS** | | |
| Virtual busway that operates bidirectionally in a single median lane that alternates direction by block. | 1 | |
| **NON-SCORING CONFIGURATIONS** | | |
| Curb-aligned busway on a two-way road | 0 | |

BRT BASICS

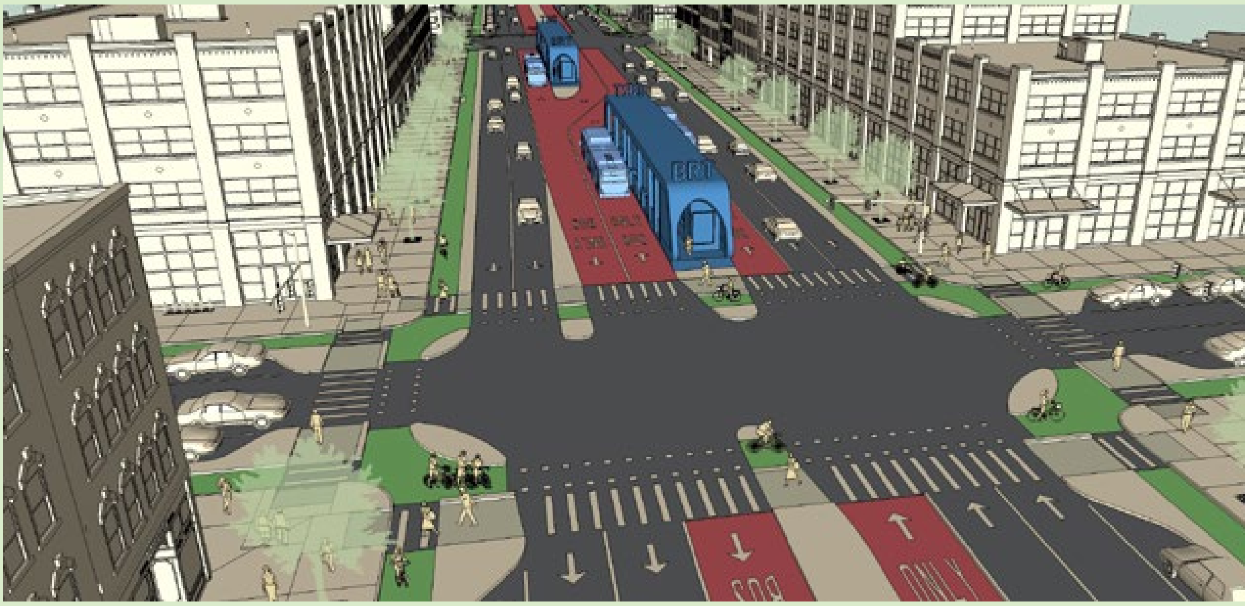
BUSWAY ALIGNMENT




## EXAMPLE OF A TWO-WAY MEDIAN-ALIGNED BUSWAY

TIER 1 CONFIGURATION

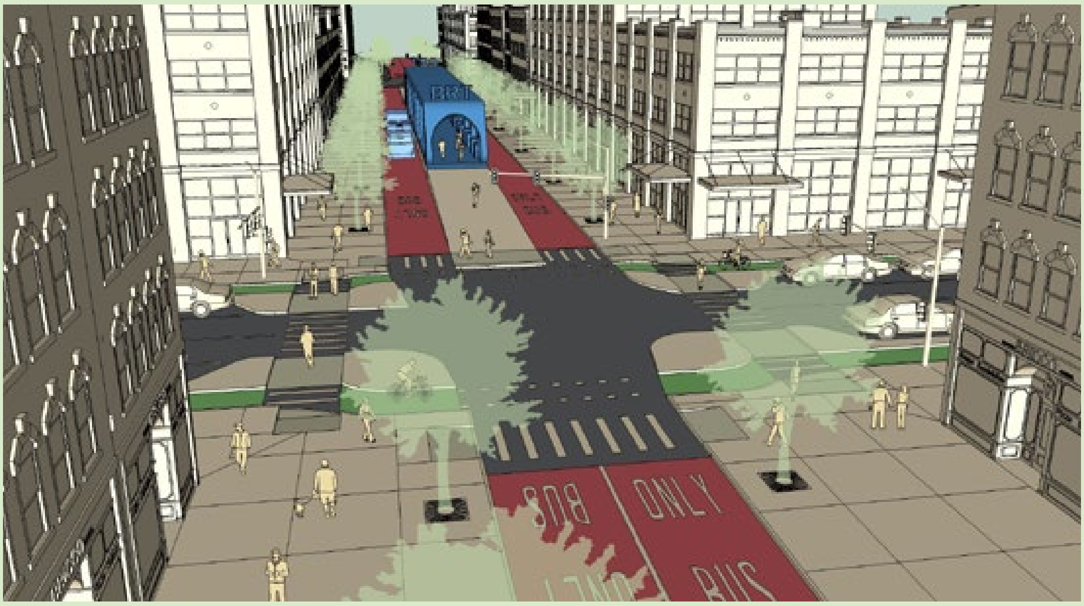
8 POINTS




## EXAMPLE OF A TWO-WAY MEDIAN-ALIGNED BUSWAY WITH PASSING LANES

TIER 1 CONFIGURATION

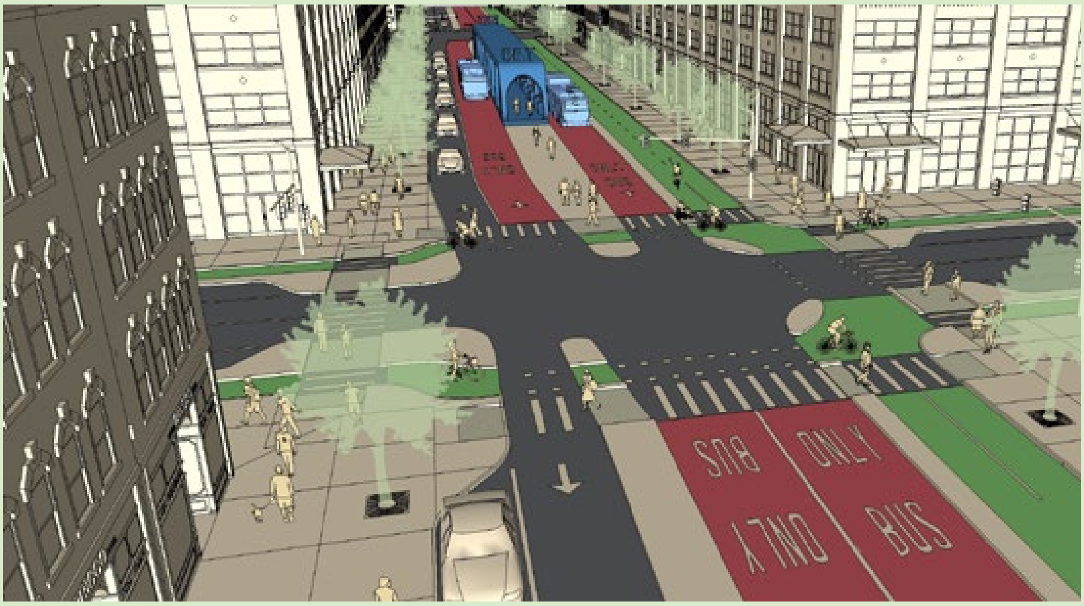
8 POINTS




**EXAMPLE OF A BUS-ONLY CORRIDOR WITH EXCLUSIVE RIGHT-OF-WAY**

TIER 1 CONFIGURATION

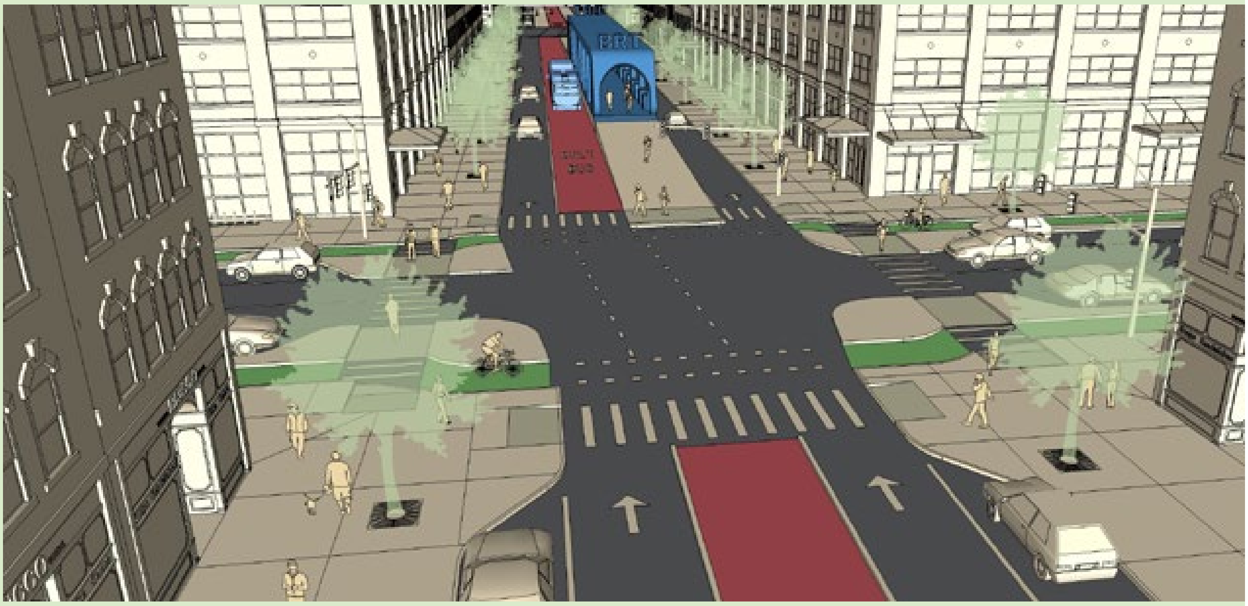
8 POINTS




**EXAMPLE OF A BUSWAY THAT RUNS TWO-WAY ON THE SIDE OF A ONE-WAY STREET**

TIER 1 CONFIGURATION

6 POINTS



## EXAMPLE OF A BUSWAY CENTRALLY ALIGNED ON A ONE-WAY STREET

TIER 2 CONFIGURATION

5 POINTS

## EXAMPLE OF A BUSWAY ALIGNED TO THE OUTER CURB OF THE CENTRAL ROADWAY ON A BOULEVARD-TYPE STREET WITH A CENTRAL ROADWAY AND PARALLEL SERVICE ROAD

TIER 2 CONFIGURATION

4 POINTS

## EXAMPLE OF A BUSWAY ALIGNED TO THE INNER CURB OF THE SERVICE ROAD ON A BOULEVARD-TYPE STREET WITH A CENTRAL ROADWAY AND PARALLEL SERVICE ROAD

TIER 2 CONFIGURATION

4 POINTS


**TOP**
A kiosk sells tickets for the proof-of-payment system used in Las Vegas, Nevada.

**BOTTOM**
Turnstiles control access into TransJakarta's stations in Jakarta, Indonesia.

# Off-board Fare Collection

## 8 points maximum

Off-board fare collection is one the most important factors in reducing travel time and improving the passenger experience.

Presently, the two most effective approaches to off-board fare collection are “barrier-controlled,” where passengers pass through a gate, turnstile, or checkpoint upon entering the station where their ticket is verified or a fare is deducted, and “proof-of-payment,” where passengers pay at a kiosk and collect paper tickets or pass with the payment marked that is occasionally checked on board the vehicle by an inspector. Both approaches can significantly reduce delays. However, barrier-controlled is slightly preferable because:

- It is easier to accommodate multiple routes using the same BRT infrastructure, without modifying the entire fare collection system for the entire urban transit network;
- It minimizes fare evasion, as every passenger must have his/her ticket scanned in order to enter the system versus proof-of-payment, which requires random checks;
- Proof-of-payment can cause anxiety for passengers who may have misplaced tickets;
- The data collected by barrier-controlled systems upon boarding, and sometimes upon alighting, can be useful in future system planning.

On the other hand, proof-of-payment systems on bus routes that go beyond BRT corridors extend the benefits of time savings to those sections of the bus routes that lie beyond the BRT corridor.

A third approach, onboard fare validation, directs passengers to purchase tickets/fares before boarding and validate them on the vehicle through rapid electronic readers available at all bus doors. While this provides time savings for passengers, it is not as efficient as barrier-controlled or proof-of-payment systems.

**BRT Basics:** this is an element of BRT deemed essential to true BRT corridors.

**Scoring Guidelines:** to be eligible for scoring, off-board fare collection needs to occur during all operating hours. Scores are weighted by the percentage of either stations or routes on the corridor that utilize that payment system. The maximum score for this element is 8 points.

| Off-Board Fare Collection (During All Operating Hours) | POINTS | WEIGHTED BY |
|---|---|---|
| Barrier-controlled | 8 | % stations on corridor |
| Proof-of-payment | 7 | % routes using corridor bus infrastructure |
| Onboard fare validation—all doors | 4 | % routes using corridor bus infrastructure |

# Intersection Treatments

## 7 points maximum

There are several ways to reduce bus delays at intersections, all of which are aimed at increasing the green-signal time for the bus lane. Forbidding turns across the bus lane and minimizing the number of traffic-signal phases where possible are the most important. Traffic-signal priority, when activated by an approaching BRT vehicle, is useful on lower-frequency corridors but is less effective than turn prohibitions.

**BRT Basics:** this is an element of BRT deemed essential to true BRT corridors.

**Scoring Guidelines:** scores are weighted by the percentage of turns prohibited or intersections with signal priority along the corridor. On corridors with grade separation, intersections that are bypassed by the grade-separated busway count as having all turns across the busway prohibited. The score is the sum of the points for turns prohibited and signal priority. While these may add up to more than 7 points, the score is capped at 7 points for this element.

| Intersection Treatments | POINTS | WEIGHTED BY |
|---|---|---|
| Turns prohibited across the busway | 7 | % of turns across busway prohibited |
| Signal priority at intersections | 2 | % of intersections on corridor |


Left turns are not allowed at this intersection along the BRT corridor in Las Vegas, Nevada.

Platform-level boarding speeds boarding and alighting in Ahmedabad, India.



# Platform-level Boarding

### 7 points maximum

Having the bus station platform level with the bus floor (i.e., eliminating the vertical gap) is one of the most important ways of reducing boarding and alighting times per passenger. Boarding configurations where passengers must climb even relatively minor steps can cause significant delays, particularly for the elderly, disabled, or people with suitcases or strollers. The reduction or elimination of the vehicle-to-platform gap (the horizontal gap) is also key to passenger safety and comfort.

"Vertical gap" refers to the difference in height between bus floors and station platforms. Vertical gaps are primarily reduced by designing station platforms and purchasing buses so that the height of the bus floors matches the height of station platforms on the corridor. Station platforms should be designed and buses selected so that the vertical distance between the platform and the bus floor is less than 1.5 centimeters (⅝ inches), although larger gaps are acceptable in *the Standard*.

"Horizontal gap" refers to the distance between the bus and the platform. There are a range of ways to achieve horizontal gaps of less than 10 centimeters (4 inches), including guided busways at stations, alignment markers, Kassel curbs, and boarding bridges. The scoring does not take into account which technique is chosen.

**BRT Basics:** this is an element of BRT deemed essential to true BRT corridors.

**Scoring Guidelines:** buses with an average vertical distance greater than 4 centimeters (1 ½ inches) between the bus floor and the station platform will not qualify as "platform level." Buses with steps inside them also will not count as platform-level. Scores for each element are weighted by the percentage of buses that are platform-level and the percentage of stations that have measures to reduce the horizontal gap. A maximum of 7 points is possible for this element.

| Platform-Level Boarding | POINTS | WEIGHTED BY |
|---|---|---|
| Buses are platform level, having 4 centimeters (1 ½ inches) or less of vertical gap | 7 | % of buses operating on corridor |
| Stations in corridor have measures for reducing the horizontal gap | 6 | % of stations on corridor |

# Service Planning

SERVICE PLANNING

MULTIPLE ROUTES

## Multiple Routes

**4 points maximum**

Having multiple routes operate on a single corridor is a good proxy for reduced door-to-door travel times by reducing transfer penalties.

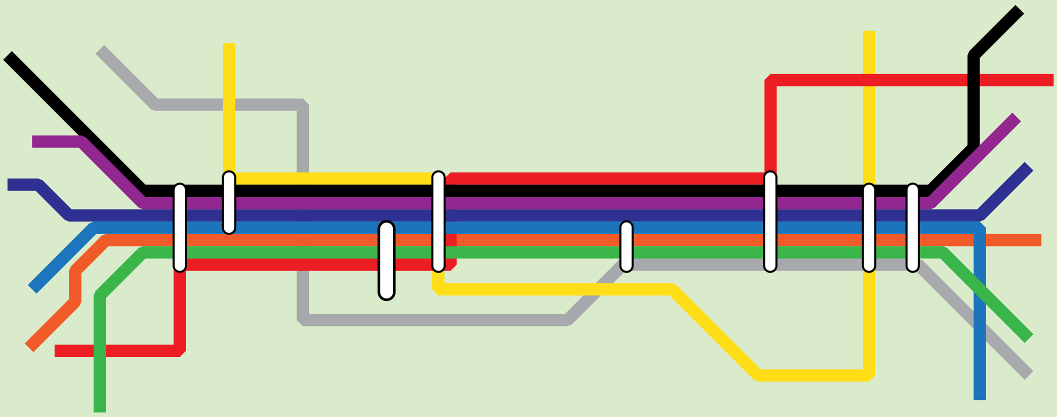
This can include:

- Routes that operate over multiple corridors, as exists with TransMilenio in Bogotá, Colombia, or Metrobús in Mexico City;
- Multiple routes operating in a single corridor that go to different destinations once they leave the corridor, as exists with the Guangzhou, China; Cali, Colombia; and Johannesburg, South Africa, BRT systems.

This flexibility of bus-based systems is one of the primary advantages of BRT that is frequently not well used or understood.

| Multiple Routes | POINTS |
|---|---|
| Two or more routes exist on the corridor, servicing at least two stations | 4 |
| No multiple routes | 0 |

**BRT Corridor**




Mexico City's Metrobús added an additional twenty thousand daily passengers by incorporating a direct route connecting Corridor I (Insurgentes) with Corridor II (Eje 4), eliminating the transfer between the two.

# Express, Limited-Stop, and Local Services

### 3 points maximum

One of the most important ways that BRT corridors increase operating speeds and reduce passenger travel times is by providing limited-stop and express services. While local services stop at every station, limited-stop services skip lower-demand stations and stop only at major stations that have higher passenger demand. Express services often collect passengers at stops at one end of the corridor, travel along much of the corridor without stopping, and drop passengers off in the city center or at the other end of the corridor.

Infrastructure necessary for the inclusion of express, limited-stop, and local BRT services is captured in other scoring metrics.

| Service Types | POINTS |
|---|---|
| Local services and multiple types of limited-stop and/or express services | 3 |
| At least one local and one limited-stop or express service option | 2 |
| No limited-stop or express services | 0 |


The BRT in Yichang, China, offers local, limited, and express services along the same corridor. Digital information tells passengers which door offers which service.

# Control Center

## 3 points maximum

Control centers for BRT systems are increasingly prevalent, allowing operators to directly monitor bus operations, identify problems, and rapidly respond to them. This can save users time and improve the quality of the BRT service.

A full-service control center monitors the locations of all buses with GPS or similar technology and can:

- Respond to incidents in real-time;
- Control the spacing of buses;
- Determine and respond to the maintenance status of all buses in the fleet;
- Record passenger boardings and alightings for future service adjustments;
- Use Computer-Aided Dispatch (CAD)/Automatic Vehicle Location (AVL) for bus tracking and performance monitoring.

A full-service center should be integrated with a public transport system's existing control center as well as the traffic signal system.

**Scoring Guidelines:** the following three elements are part of a full-service control center: 1) automated dispatch, 2) active bus control, and 3) AVL.

| Control Center | POINTS |
|---|---|
| Full-service control center with all three services | 3 |
| Control center with two of the three services | 2 |
| Control center with one of the three services | 1 |
| No control center or center with limited functionality | 0 |


The control center in Rio de Janeiro, Brazil, allows the operator to monitor BRT service across the system.

# Located In Top Ten Corridors

## 2 points maximum

If the BRT corridor is located along one of the top ten corridors, in terms of aggregate bus ridership, this will help ensure that a significant proportion of passengers benefit from the improvements. Points are awarded to systems that have made a good choice for the BRT corridor, regardless of the level of total demand.

**Scoring Guidelines:** if all top ten demand corridors have already benefited from public transport infrastructure improvements and the corridor thus lies outside the top ten, all points are awarded.

| Corridor Location | POINTS |
|---|---|
| Corridor is one of top ten demand corridors | 2 |
| Corridor is not one of top ten demand corridors | 0 |


This map showing the demand from road-based transit highlights that the first corridor of Johannesburg's BRT (in red) is one of the top corridors. The higher the demand the wider the green and red lines.

# Demand Profile

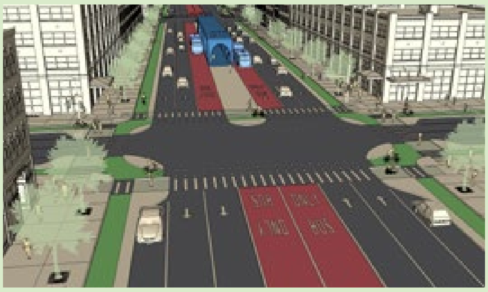
### 3 points maximum

Building dedicated BRT infrastructure in the highest-demand segments of a road ensures that the greatest number of passengers benefit from the improvements. This is most significant when the decision is made whether or not to build a corridor through a downtown area; however, it can also be an issue outside of a downtown on a road segment that has areas with particularly high demand. Building BRT infrastructure through the highest demand parts of a route will save users time and improve the quality of the service.

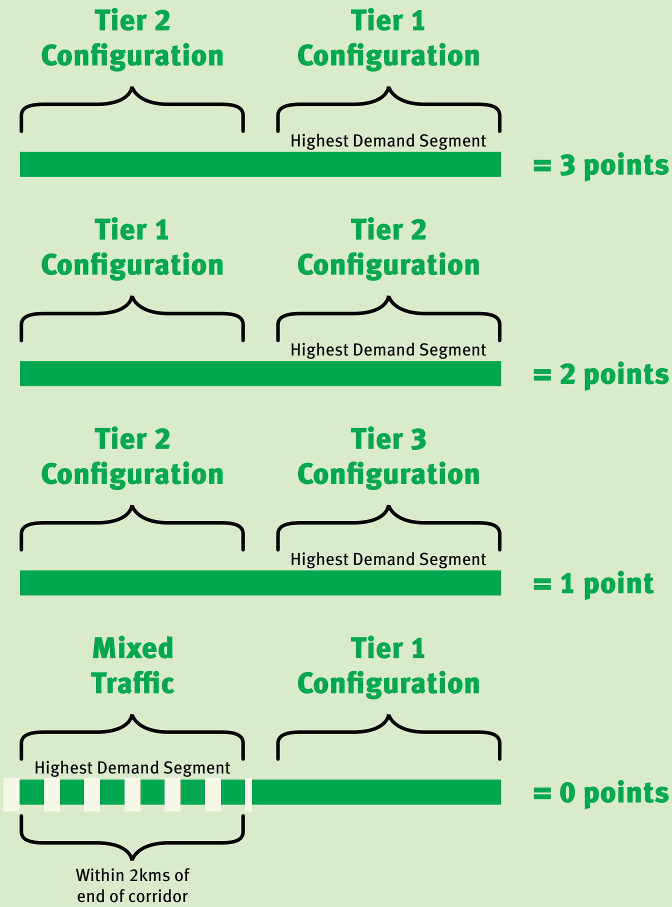
**Scoring Guidelines:** the BRT corridor must include dedicated infrastructure for the road segment with the highest demand within a 2-kilometer (1.2 miles) distance of either end of the corridor. This segment should also have the highest quality of busway alignment in that section, and the score thus relates to that. The trunk corridor configurations defined in the Busway Alignment Section (see page 29) are used here to score the demand profile.

| Demand Profile | POINTS |
|---|---|
| Corridor includes highest demand segment, which has a Tier 1 Trunk Corridor configuration | 3 |
| Corridor includes highest demand segment, which has a Tier 2 Trunk Corridor configuration | 2 |
| Corridor includes highest demand segment, which has a Tier 3 Trunk Corridor configuration | 1 |
| Corridor does not include highest demand segment | 0 |

**Tier 1 Example**



**Tier 2 Example**




*For more detail about the tiers and more examples, please see page 29, Busway Alignment.*

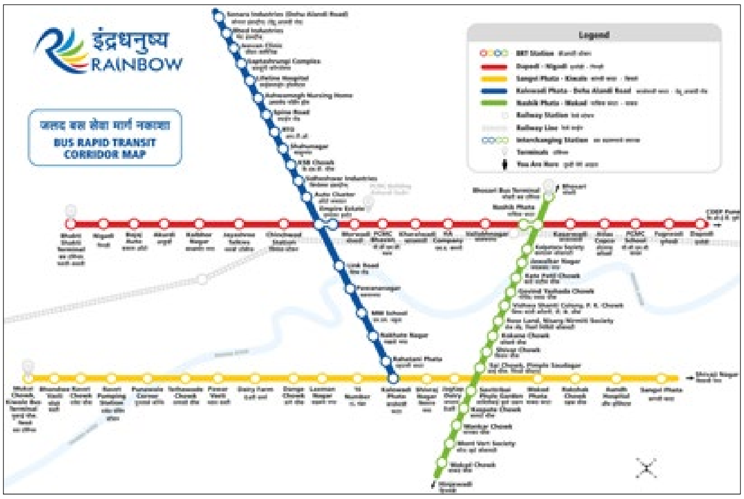
# Hours of Operation

## 2 points maximum

A viable transit corridor with a high quality of service must be available to passengers for as many hours throughout the day and week as possible. Otherwise, passengers could end up stranded or may simply seek another mode of transport.

**Scoring Guidelines:** late-night service refers to service until midnight and weekend service refers to both weekend days.

| Operating Hours | POINTS |
|---|---|
| Both late-night and weekend service | 2 |
| Late-night service, no weekends or weekend service, no late nights | 1 |
| No late-night or weekend service | 0 |




The Rainbow BRT in Pimpri-Chinchwad, India offers a multi-corridor network with interchanges.

# Multi-Corridor Network

## 2 points maximum

Ideally, BRT should include multiple corridors that intersect and form a network, as this expands travel options for passengers and makes the system more viable as a whole, improving the level of service experienced by users. When designing a new system, some anticipation of future corridors is useful to ensure that the designs will be compatible with later developments. For this reason, a long-term plan is recognized, with an emphasis on near-term connectivity through either BRT services or infrastructure.

| Multi-Corridor Network | POINTS |
|---|---|
| BRT corridor connects to an existing BRT corridor or to the next one planned in the network | 2 |
| BRT corridor connects to a future planned corridor in the BRT network | 1 |
| No connected BRT network planned or built | 0 |

# Infrastructure



## Passing Lanes at Stations

**3 points maximum**

Passing lanes at station stops are critical to allow both express and local services. They also enable stations to accommodate a high volume of buses without getting congested with buses backed up waiting to enter. On corridors with lower bus frequencies, however, it is more difficult politically to justify devoting street space to passing lanes, if those lanes appear to be unoccupied much of the time. Passing lanes are typically a good investment in the medium term, yielding multiple service options and considerable passenger travel-time savings and allowing for flexibility as a system grows.

On high-demand corridors requiring frequent service, passing lanes at stations are particularly helpful for providing sufficient corridor capacity to maintain higher speeds. Corridors with growing demand may not have high capacities at first, but passing lanes can permit extensive growth in ridership without saturating the corridor. Passing lanes also permit a variety of service options, such as express services, which can be helpful even in lower-demand corridors. In some instances, many of the benefits of passing lanes can be provided by allowing BRT buses to pass in oncoming dedicated bus lanes. However, for safety reasons this should only be done where there is good visibility and relatively low bus frequencies. Similarly, BRT corridors may also allow buses to pass in mixed traffic lanes. But this is mainly useful in locations with low bus frequencies and limited mixed-traffic congestion.

| Passing Lanes | POINTS |
|---|---|
| Dedicated passing lanes | 3 |
| Buses overtake in oncoming dedicated bus lanes given safe conditions | 2 |
| Passing in mixed traffic given safe conditions | 1 |
| No passing lanes | 0 |

The Belo Horizonte MOVE BRT allows for passing lanes at many stations, greatly increasing capacity and allowing for a variety of service options.


Rea Vaya in Johannesburg introduced Euro IV buses for the first time to South Africa.

# Minimizing Bus Emissions

## 3 points maximum

Bus tailpipe emissions are typically a large source of urban air pollution. Especially at risk are bus riders and people living or working near roadsides. In general, the pollutant emissions of highest concern from urban buses are particulate matter (PM) and nitrogen oxides ($NO_x$). Minimizing these emissions is critical to the health of both passengers and the general urban population and for creating a high-quality service that can attract and retain passengers.

The primary determinant of tailpipe emission levels is the stringency of governments' emissions standards. While some fuels, like natural gas, tend to produce lower emissions, new emission controls have enabled even diesel buses to meet extremely clean standards. However, "clean" fuels do not guarantee low emissions of all pollutants. As a result, the scoring is based on certified emissions standards rather than fuel type.

Over the past two decades, the European Union and the United States have adopted a series of progressively tighter emissions standards that are being used for this scoring system. Buses must be in compliance with Euro VI and U.S. 2010 emissions standards to receive 3 points. These standards result in extremely low emissions of both PM and $NO_x$. For diesel vehicles, these standards require the use of PM traps, ultra-low-sulfur diesel fuel, and selective catalytic reduction. To receive 2 points, buses need to be certified to Euro IV or V with PM traps (note: 50 ppm sulfur diesel fuel or lower is required for PM traps to function effectively).

Vehicles certified to the Euro IV and V standards that do not require traps emit twice as much PM as vehicles meeting more recent standards. Therefore, these vehicles are awarded 1 point. Ideally, buses will include contractually stipulated requirements in the purchase order to control real-world $NO_x$ emissions from buses in use, because the actual $NO_x$ emissions from urban buses certified to Euro IV and V have been tested at levels substantially higher than certified levels. Because that is hard to verify, it is included as a recommendation, but not as a requirement, for receiving the 1 point.

Zero points are awarded for U.S. 2004 and Euro III standards and less stringent standards, because these standards allow ten times as much PM emissions as the U.S. 2010 and Euro VI standards.

**Buses also generate greenhouse gas emissions. Since no clear regulatory framework exists that requires bus manufacturers to meet specific greenhouse-gas emission targets or fuel-efficiency standards, there is no obvious way to identify a fuel-efficient bus by vehicle type. For $CO_2$ impacts, we recommend the use of the TEEMP model, which incorporates the BRT Standard into a broader assessment of project-specific $CO_2$ impacts.**

Other countries have established emissions standards, such as the Bharat Stage Standard in India, the China National Standard, and CONAMA PROCONVE Standards in Brazil. These countries often develop their regulations based on either the U.S. or the Euro standards and should be relatively comparable. With Bharat, the highest standard as of 2015 is currently Stage IV, which is comparable to Euro IV and thus eligible for 1 point.

| Emissions Standards | POINTS |
|---|---|
| Euro VI or US 2010 | 3 |
| Euro V with PM traps, Euro IV with PM traps, or U.S. 2007 | 2 |
| Euro V, Euro IV, Euro III CNG, or Euro III using verified PM trap retrofit | 1 |
| Below the above standards | 0 |

# Stations Set Back from Intersections

### 3 points maximum

Stations should be located at minimum 26 meters (85 feet), but ideally 40 meters (130 feet), from intersections to avoid delays. When stations are located just beyond an intersection, delays can occur when passengers take a long time to board or alight and the docked bus blocks others from pulling through the intersection. If stations are located just before an intersection, the traffic signal can keep buses from leaving the station and thus not allow other buses to pull in. The risk of conflict remains acute, particularly as frequency increases. Separating stations from intersections is a key way to mitigate these problems.

**Scoring Guidelines:** the distance from the intersection is defined for the near side of the intersection as the stop line at the intersection to the front of a bus at the forward-most docking bay and for the far side of the intersection from the far edge of the crosswalk to the back of the bus at the rear-most docking bay. A station may be exempted from the minimum setback if:

- The stations are located on fully grade-separated busways with no intersections;
- The stations are located near intersections due to short block length (less than 100 meters/330 feet);

| Station Location | POINTS |
|---|---|
| 75% of stations on corridor are set back at least 40 meters (130 feet) from intersections or meet at least one of the above exemptions | 3 |
| 75% of stations on corridor are set back 26 meters (85 feet) from intersections or meet above exemptions | 2 |
| 25% of stations on corridor are set back 26 meters (85 feet) from intersections or meet above exemptions | 1 |
| < 25% of stations on corridor are set back 26 meters (85 feet) from intersections or meet above exemptions | 0 |


Janmarg, in Ahmedabad, India, has stations that are not immediately adjacent to the intersection.


Center stations in the Metrobus Q BRT system in Quito minimize station space requirements and allow easy transfers between different directions of travel.

# Center Stations

## 2 points maximum

Having a single station serving both directions of the BRT corridor makes transfers between the two directions easier and more convenient—something that becomes more important as a BRT network expands. It also tends to reduce construction costs and minimize the necessary right-of-way. In some cases, stations may be centrally aligned but split into two—called split stations, with each station housing a particular direction of the BRT corridor. If a physical connection between the two directions is not provided, fewer points are awarded.

Bilateral stations (those that, while in the central verge, are at the outer edge of the busway) get no points.

**Scoring Guidelines:** the corridor receives points for center platforms, based on their prevalence and type.

| Center Stations | POINTS |
|---|---|
| ›80% of stations on corridor have center platforms serving both directions of service | 2 |
| ›50% of stations on corridor have center platforms serving both directions of service | 1 |
| ›80% and above of stations on corridor have center platforms serving only one direction of service (e.g., Lanzhou BRT, see figure below) | 1 |

The Lanzhou BRT system has center stations that only serve one direction of travel.

# Pavement Quality

## 2 points maximum

Good-quality pavement ensures better service and operations for a longer period by minimizing the need for maintenance on the busway. Roadways with poor-quality pavement will need to be shut down more frequently for repairs. Buses will also have to slow down to drive carefully over damaged pavement. A smooth ride is critical for creating a high-quality service that can attract and retain customers.

No matter what type of pavement, a thirty-year life span is recommended. There are several options for the pavement structure to achieve that time span, with advantages and disadvantages for each. Three examples are described here:

**1. Asphalt:** properly designed and constructed, asphalt pavement can last thirty-plus years with surface replacement every ten to fifteen years. This can be done without interrupting service, resulting in a smooth, quiet ride. At stations and intersections, rigid pavement bus pads are important to use to resist the potential pavement damage due to braking of vehicles, a problem which is most acute in hot climates. Bus pads are constructed using cement concrete over a layer of aggregate, with dowels and/or varying amounts of reinforcing steel depending on design conditions. Each bus pad should be 1.5 times as long as the total length of buses using it at any time;

**2. Jointed Plain Concrete Pavement (JPCP):** this type of pavement design can have a thirty-plus-year life. To ensure this life, the pavement must have round dowel bars at the transverse joints, tied lanes by the use of reinforcing steel, and adequate thickness;

**3. Continuously Reinforced Concrete Pavement (CRCR):** continuous slab reinforcement can add additional pavement strength and might be considered under certain design conditions

| Pavement Materials | POINTS |
|---|---|
| Pavement structure designed for thirty-year life over entire corridor | 2 |
| Pavement structure designed for thirty-year life only at stations and intersections | 1 |
| Pavement structure designed for thirty-year life, except at stations and intersections | 1 |
| Pavement design life less than thirty years | 0 |

Lima, Peru, uses reinforced concrete over its entire busway.

# Stations



Guangzhou, China has well-spaced BRT stations.

## Distances Between Stations

### 2 points maximum

In a consistently built-up area, the distance between station stops optimizes at around 450 meters (1,500 feet). Beyond this, more time is imposed on customers walking to stations than is saved by higher bus speeds. Below this distance, bus speeds will be reduced by more than the time saved with shorter walking distances. Thus, in keeping reasonably consistent with optimal station spacing, average distances between stations should not be below 0.3 kilometers (0.2 miles) or exceed 0.8 kilometers (0.5 miles).

**Scoring Guidelines:** two points should be awarded if stations are spaced, on average, between 0.3 kilometers (0.2 miles) and 0.8 kilometers (0.5 miles) apart.

| Distance Between Stations | POINTS |
|---|---|
| Stations are spaced, on average, between 0.3 kilometers (0.2 miles) and 0.8 kilometers (0.5 miles) apart | 2 |

STATIONS

SAFE AND COMFORTABLE STATIONS

# Safe and Comfortable Stations

## 3 points maximum

One of the main distinguishing features of a BRT corridor as opposed to standard bus service is a safe and comfortable station environment, an important feature of a high-quality service. Four main factors contribute to that:

**1. Wide:** stations should be wide enough for passengers to move easily through them and stand without feeling like they are overcrowded. Overcrowded stations are more likely to encourage pickpocketing and harassment. Stations should have a minimum internal width of at least 3 meters (10 feet), and wider widths at stations with higher passenger volumes;

**2. Weather-protected:** stations should be weather-protected, including from wind, rain, snow, heat and/or cold, as appropriate to the conditions in a specific location;

**3. Safe:** stations that are well-lit, transparent, and have security—whether through security guards or cameras—are essential to maintaining ridership;

**4. Attractive:** a clear intention to create attractive stations is also important to the image of the BRT corridor and creates a sense of permanence and attractiveness that will attract not only riders but developers as well. Stations should be considered part of municipal infrastructure and foster civic and community pride.

**Scoring Guidelines:** the scoring is determined by multiplying the percentage of the stations with each quantity of elements of safe and comfortable stations by the points associated with that number of elements. A maximum of 3 points is possible.

| Stations | POINTS | WEIGHTED BY |
|---|---|---|
| Stations have all four elements | 3 | % of stations |
| Stations have three elements | 2 | |
| Stations have two elements | 1 | |
| Stations have one element | 0 | |

Stations in the El Mio BRT system in Cali, Colombia, are comfortable and attractive.


Articulated BRT buses in Nantes, France, have four doors for boarding and alighting quickly.

# Number of Doors on Bus

## 3 points maximum

The speed of boarding and alighting is partially a function of the number of bus doors. Much like a subway in which a car has multiple wide doors, buses need the same to let higher volumes of people on and off the buses quickly, saving time for users. One door or narrow doorways become bottlenecks that delay the bus.

**Scoring Guidelines:** buses need to have three or more doors on the station side of the bus for articulated buses or two wide (defined as at least 1 meter wide) doors on the station side for regular (non-articulated) buses and allow boarding through all doors to qualify for the points below. Points are weighted based on the percentage of buses using the corridor infrastructure, with a maximum score of 3.

| Stations | POINTS | WEIGHTED BY |
|---|---|---|
| Buses have at least three Doors (for articulated buses) or two Wide Doors (for non-articulated buses) on the Station Side. System allows boarding at all doors. | 3 | % of buses using corridor infrastructure meeting criteria |

# Docking Bays and Substops

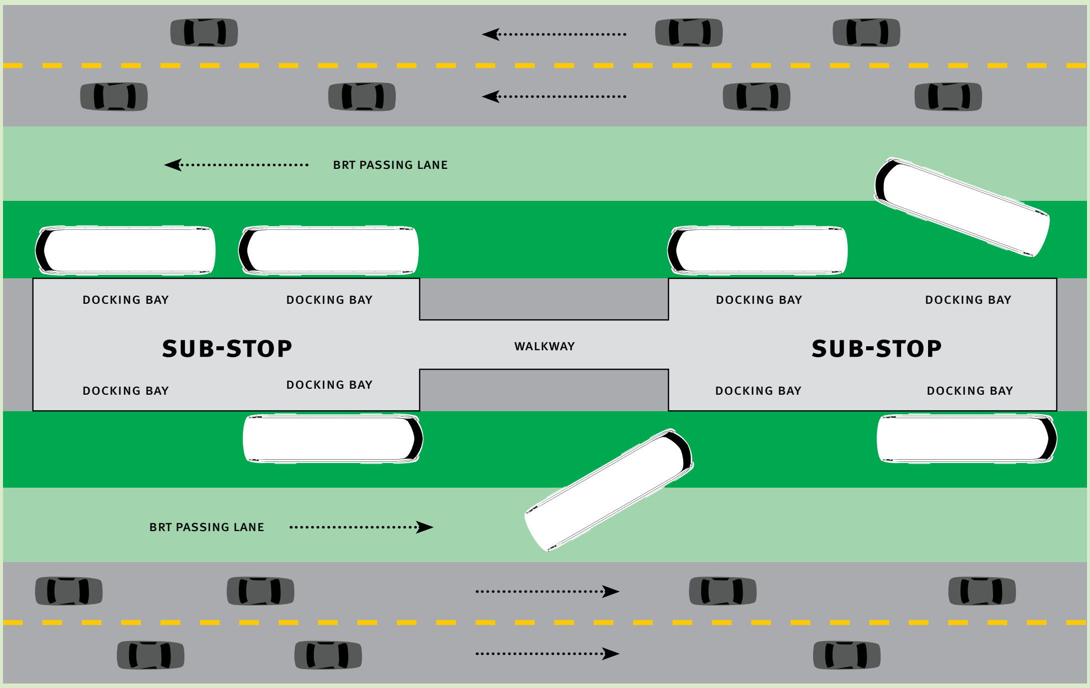
## 1 point maximum

Multiple docking bays and substops not only increase the capacity of a station, saving users time, but they also help stations provide multiple services.

A station is composed of substops that can connect to one another but should be separated by a walkway long enough to allow buses to pass one substop to dock at another. This reduces the risk of congestion by allowing a bus to pass a full substop where buses can let passengers on and off. They are usually adjacent to each other and allow a second bus to pull up behind another bus already at the station. A station may be composed of only one substop.

| Docking Bays and Substops | POINTS |
|---|---|
| At least two substops or docking bays at the highest-demand stations | 1 |
| Less than two substops or docking bays at the highest-demand stations | 0 |

### Example of Substops with Multiple Docking Bays




Lima, Peru has sliding doors where the bus docks at the station.

# Sliding Doors in BRT Stations

## 1 point maximum

Sliding station doors where passengers get on and off the buses improve the quality of the station environment, reduce the risk of accidents, protect passengers from the weather, and prevent pedestrians from entering the station in unauthorized locations.

| Sliding Doors | POINTS |
|---|---|
| All stations have sliding doors | 1 |
| Otherwise | 0 |

Guangzhou, China's BRT has sliding doors at the gates.

# Communications

Las Vegas, Nevada, has a good brand and strong identity that appeals to its customers—from the stations to the buses.

Las Vegas, Nevada, used old casino signs at stations, which reinforced the city's identity.

## Branding

**3 points maximum**

BRT promises a high quality of service, which is reinforced by having a unique brand and identity.

| Branding | POINTS |
| --- | --- |
| All buses, routes, and stations in corridor follow single unifying brand of entire BRT system | 3 |
| All buses, routes, and stations in corridor follow single unifying brand, but differ from rest of system | 2 |
| Some buses, routes, and stations in corridor follow single unifying brand, regardless of rest of system | 1 |
| No corridor brand | 0 |

# Passenger Information

## 2 points maximum

Numerous studies have shown that customer satisfaction is linked to knowing when the next bus will arrive. Giving customers information is critical to a high quality of service and a positive overall experience.

Real-time passenger information, based on GPS data, includes electronic panels, digital audio messaging (“Next bus” at stations, “Next stop” on buses), and/or dynamic information on handheld devices. Static passenger information refers to station and vehicle signage, including network maps, route maps, local area maps, emergency indications, and other user information. Passenger information should be visible from buses, stations, and nearby sidewalks in order to qualify.

More and more customers are accessing information online, including route maps, arrival times/schedules, and services alerts. A variety of means for online information sharing exist—from websites to apps to social media. This is increasingly important for conveying information to customers, as well as receiving feedback and addressing problems, especially using social media to engage with customers. This type of information should be part of a complete passenger information system, but for points, the *Standard* only scores passenger information at and near stations and on buses. Many systems still have trouble achieving this type of information, which should be the cornerstone of good communication.

**Scoring Guidelines:** scores are assigned based on which of the following criteria describes the corridor.

| Passenger Information (at Stations and on Vehicles) | POINTS |
|---|---|
| Functioning real-time and up-to-date static passenger information corridor-wide | 2 |
| Up-to-date static passenger information | 1 |


Guangzhou, China, has real-time passenger information systems.

# Access and Integration

## Universal Access

**3 points maximum**

A BRT corridor should be accessible to all special-needs customers, including those who are physically, visually, and/or hearing impaired, as well as those with temporary disabilities, the elderly, children, people with strollers, and other load-carrying passengers. Universal access is important to maintaining a high quality of service for all customers, regardless of their abilities.

**Scoring Guidelines:** accessibility includes two elements: physical and audiovisual. Physical accessibility means that all stations, vehicles, and fare gates on the corridor are universally accessible for people using wheelchairs, and stations must be free of obstacles that impede movement. The corridor must also include drop curbs at all immediate intersections. Audiovisual accessibility means that there are Braille readers at all stations and Tactile Ground Surface Indicators leading to all stations. Scores are determined by measuring the percentage of stations and buses that provide each level of access by the points associated with that level and tallying the result. A maximum of 3 points is possible.

| Universal Accessibility | POINTS |
|---|---|
| Full accessibility provided | 3 |
| Physical accessibility provided | 2 |
| Audiovisual accessibility provided | 1 |

Metrobús in Mexico Mexico City provides universal access to people in wheelchairs.

# Integration with Other Public Transport

### 3 points maximum

When a BRT corridor is built in a city, a functioning public transport network often already exists, be it rail, bus, or minibus. The BRT corridor should integrate into the rest of the public transport network, saving customers time and creating a more seamless high-quality experience. There are two components to BRT integration:

- **Physical transfer points:** physical transfer points should minimize walking between modes, be well-sized, and not require passengers to completely exit one system and travel a distance to enter another;
- **Fare payment:** the fare system should be integrated so that one fare card may be used for all modes.

**Scoring Guidelines:** the BRT corridor should integrate physically with other rapid transit modes (BRT, LRT, and metro) where lines cross the corridor. If no lines cross, points may still be awarded for fare integration with other public transport modes. If no other formal public transport modes exist in the city, full points may be awarded for all aspects of integration.

| Integration with Other Public Transport | POINTS |
|---|---|
| Integration of both physical design and fare payment | 3 |
| Integration of physical design or fare payment only | 2 |
| No integration | 0 |


Guangzhou, China, has physical integration, such as this tunnel connecting the BRT to the metro.

ACCESS

INTEGRATION WITH OTHER PUBLIC TRANSPORT

# Pedestrian Access and Safety

## 4 points maximum

A BRT corridor could be extremely well-designed and functioning but if customers cannot access it safely, it cannot achieve its goals. Good pedestrian access is imperative in BRT corridor design. Additionally, a new BRT corridor is a good opportunity to improve the pedestrian environment on the streets and public-spaces along the corridor and on side streets leading to stations. Good access to the corridor is vital for creating a high level of service for users.

Good pedestrian access includes all of the following:

- At-grade pedestrian crossings where pedestrians cross a maximum of two lanes of traffic before reaching a pedestrian refuge (sidewalk, median). While at-grade crossings are preferred, pedestrian bridges or underpasses with working escalators or elevators can also be considered;
- Safe crossings provided on average every 200 meters (650 feet) in areas where there is continuous activity on both sides of the corridor;
- Signalized crosswalks where pedestrians must cross more than two lanes at once;
- Table-top crossings or speed bumps to slow down traffic when approaching unsignalized crosswalks;
- Signals timed so that pedestrian waiting time is not excessive (i.e., generally below 30–45 seconds);
- Wide (at least 2 meters), well-lit, well-demarcated crosswalks where the footpath remains level and continuous or ramps exist to ensure accessible crossings;
- Dedicated and protected sidewalks along corridor that are at least 3 meters (10 feet) wide and unobstructed, including from encroachment from parked vehicles, debris, signs, and street vendors;
- Direct station access, with no time-consuming detours and other delays;
- Posted speed limits set to prioritize safety (e.g., below 30 kilometers per hour in dense urban centers);
- Design that matches posted speed limits to prevent speeding and help with enforcement.

| Pedestrian Access | POINTS |
|---|---|
| Good, safe pedestrian access at every station and many improvements along corridor | 4 |
| Good, safe pedestrian access at every station and modest improvements along corridor | 3 |
| Good, safe pedestrian access at every station and no other improvements along corridor | 2 |
| Good, safe pedestrian access at most stations and no other improvements along corridor | 1 |
| Stations lack good, safe pedestrian access | 0 |

Metrobús in Mexico City provides good pedestrian access to stations.

# Secure Bicycle Parking

## 2 points maximum

Bicycle parking at stations allows customers to use bicycles as feeders to the BRT corridor, increasing system coverage. More options for accessing the BRT corridor can save users time and create a higher quality experience. Formal bicycle parking facilities that are secure (either monitored by an attendant or observed by security cameras) and weather-protected are more likely to be used by customers.

| Bicycle Parking | POINTS |
|---|---|
| Secure bicycle parking at least in higher-demand stations and standard bicycle racks elsewhere | 2 |
| Standard bicycle racks in most stations | 1 |
| Little or no bicycle parking | 0 |



Secure bike parking is provided at a TransMilenio terminal in Bogotá, Colombia.

A bike locker along the Orange Line in Los Angeles provides secure bicycle storage.

# Bicycle Lanes

## 2 points maximum

Bicycle-lane networks integrated with the BRT corridor improve customer access, provide a full set of sustainable travel options, and enhance road safety. This can save time and improve the quality of the experience for users of the corridor.

Bicycle lanes and bicycle-friendly streets should ideally connect BRT stations to all major residential areas, commercial centers, schools, and business centers within 2 kilometers (1.2 miles). This helps the BRT by providing a low-cost feeder to the system, and by connecting riders safely and comfortably to their destinations. Also, by ensuring that the BRT corridor is designed as a complete street, it increases the safety of all users of the corridor.

Moreover, in most cities, the best BRT corridors are also the most desirable bicycle routes, as they are often the routes with the greatest travel demand. Yet there is a shortage of safe cycling infrastructure on those same corridors. If some accommodation for cyclists is not made, it is possible that cyclists will use the busway. If the busway has not been designed for dual bike and bus use, it is a safety risk for cyclists. Bicycle lanes should be built either within the same corridor or on a nearby parallel street and should be at least 2 meters (6.5 feet), for each direction, of unimpeded width.

| Bicycle Lanes | POINTS |
|---|---|
| Bicycle lanes on or parallel to entire corridor | 2 |
| Bicycle lanes do not span entire corridor | 1 |
| Poorly-designed or no bicycle infrastructure | 0 |

A bikeway is located parallel to MyCiTi, in Cape Town, South Africa.

# Bicycle-Sharing Integration

## 1 point maximum

Having the option to make short trips from the BRT corridor by a shared bicycle is important to providing connectivity to some destinations. Operating costs of providing bus service to the last mile (i.e., feeder buses) are often the highest cost of maintaining a BRT network; thus, providing a low-cost bicycle-sharing alternative to feeders is generally seen as best practice. Providing this option can save users time and improve the quality of their experience, while increasing the coverage of the transit system.

| Bicycle-Sharing Integration | POINTS |
|---|---|
| Bicycle-sharing at minimum of 50% of stations on corridor | 1 |
| Bicycle-sharing at <50% of stations on corridor | 0 |



A bike-share station is located along a BRT corridor in Nantes, France.

# Operations Deductions

Operations deductions are only relevant to corridors already in operation. They have been introduced as a way of mitigating the risk of recognizing a corridor as high quality that has made significant design errors or has significant management and performance weaknesses not readily observable during the design phase. The penalties from improperly sizing the infrastructure and operations or from poor corridor management are as follows:

## Commercial Speeds

**-10 points maximum**

Most of the design features included in the scoring system will always result in higher speeds. However, there is an exception: higher-demand corridors in which too many buses carrying too many passengers have been concentrated into a single lane. In this case, bus speeds could be lower than in mixed-traffic conditions. This penalty was imposed to mitigate the risk of rewarding such a corridor with a quality standard.

**Scoring Guidelines:** the minimum average commercial speed refers to the corridor-wide average speed and not the average speed at the slowest link. To measure commercial speeds along a corridor, divide the total distance travelled along the corridor by the total time to travel the corridor or use the average speed from a GPS measurement. Where commercial speed is not readily available, the full penalty should be imposed if buses are backing up at many BRT stations or junctions.

| Commercial Speeds | POINTS |
|---|---|
| Minimum average commercial speed is 20 kilometers per hour (12 miles per hour) and above | 0 |
| Minimum average commercial speed is 16 kilometers per hour–19 kilometers per hour (10–12 miles per hour) | -3 |
| Minimum average commercial speed is 13 kilometers per hour–16 kilometers per hour (8–10 miles per hour) | -6 |
| Minimum average commercial speed is 13 kilometers per hour (8 miles per hour) and below | -10 |

# Peak Passengers per Hour per Direction (pphpd) Below 1,000

**-5 points**

BRT corridors with ridership levels below a thousand passengers per hour per direction (pphpd) during the peak hour are carrying fewer passengers than a normal mixed-traffic lane. Very low ridership can be an indication that other bus services continue to operate in the corridor alongside and in competition with the BRT services. Alternatively, such low ridership indicates that a corridor was poorly selected.

Almost all cities have corridors carrying at least a thousand pphpd during the peak hour. Many cities, however, have corridors where transit demand is very low, even below this level. While many Gold Standard BRT features would still bring benefits in these conditions, it is unlikely that such levels would justify the cost and dedicated right-of-way intrinsic to BRT. This penalty has been created to penalize BRT corridors that have poor service planning or are not well-selected, but the threshold is intended to be low enough to avoid overly penalizing corridors in smaller cities with lower transit demand.

**Scoring Guidelines:** all 5 points should be deducted if the ridership on the link in the corridor with maximum peak-hour ridership is under a thousand pphpd in the peak hour. Otherwise, no deduction is necessary.

| Passengers per Hour per Direction (PPHPD) in Peak Hour | POINTS |
|---|---|
| PPHPD below a thousand | -5 |

# Lack of Enforcement of Right-of-Way

**-5 points maximum**

A BRT corridor may have a good alignment and physical separation, but if the right-of-way is not enforced, bus speeds will decline. This penalty addresses corridors that do not adequately enforce the busway to prevent encroachment from other vehicles. There are multiple and somewhat context-specific means of enforcing the exclusive right-of-way. The committee generally recommends onboard camera enforcement and regular policing at points of frequent encroachment, coupled with high fines for violators, to minimize invasions of the lanes by nonauthorized vehicles. Solely relying on camera enforcement deployed at high-risk locations is somewhat less effective.

| Lack of Enforcement | POINTS |
|---|---|
| Regular encroachment on BRT right-of-way | -5 |
| Some encroachment on BRT right-of-way | -3 |
| Occasional encroachment on BRT right-of-way | -1 |

DEDUCTIONS

# Significant Gap Between Bus Floor and Station Platform

**-5 points maximum**

Even corridors that have been designed to accommodate platform-level boarding could have horizontal gaps if the buses do not dock properly. A significant horizontal gap between the platform and the bus floor undermines the time-savings benefits of platform-level boarding and introduces a significant safety risk for passengers. Such gaps occur for a variety of reasons, from poor basic design to poor driver training. Technical opinion varies on the best way to minimize the horizontal gap. Most experts feel that optical guidance systems are more expensive and less effective than measures such as the use of simple painted alignment markers and special curbs at station platforms where the drivers are able to feel the wheel touching the curb yet the curb does not damage the wheel. Boarding bridges are used successfully on many corridors and would tend to eliminate gap problems.

**Scoring Guidelines:** a "minor horizontal gap" is defined as 15–20 centimeters (6–8 inches) and a "major horizontal gap" is defined as greater than 20 centimeters (8 inches). A sample of at least twenty instances of buses docking at stations should be used to determine scoring. The percentage of docking instances observed with each type of gap should be multiplied by the associated deduction and tallied. The maximum possible deduction is -5.

Note: If a corridor does not have platform-level boarding by design, no penalty points should be given. Deductions for significant gaps must not exceed the points awarded for Platform-Level Boarding.

| Gap when Docking | POINTS | WEIGHTED BY |
|---|---|---|
| Major horizontal gap | -5 | % of observed dockings |
| Minor horizontal gap | -3 | |

# Overcrowding

**-5 points**

This criterion was included because many corridors that are generally well-designed are so overcrowded that they become alienating to customers. While average "passenger standing density" is a reasonable indicator, getting this information is not easy, so a more subjective measure is allowed in cases of obvious overcrowding.

**Scoring Guidelines:** the full penalty should be imposed if the average passenger standing density during the peak hour is greater than five passengers per square meter (0.46 per square feet) on more than 25% of buses on the critical link in the predominant direction, or the average passenger standing density during the peak hour is greater than three passengers per square meter (0.28 per square feet) at stations.

If this metric is not easily calculated, then clearly visible signs of overcrowding on buses or in stations should be used, such as doors on the buses regularly being unable to close, stations overcrowded with passengers because they are unable to board full buses, and so forth.

| Overcrowding | POINTS |
|---|---|
| Passenger density during peak hour on more than 25% of buses on critical link in peak direction is › 5 $m^2$ | -5 |
| Passenger density during peak hour at one or more stations is › 3 $m^2$ | |
| Passengers unable to board buses or enter stations | |

# Poorly Maintained Busway, Buses, Stations, and Technology Systems

**-14 points maximum**

Even a BRT corridor that is well built and attractive can fall into disrepair. It is important that the busway, buses, stations, and technology systems be regularly maintained. A corridor can be penalized for each type of poor maintenance listed below for a total of -14 points.

| Maintenance of Busway | POINTS |
|---|---|
| Busway has significant wear, including potholes or warping, or debris such as trash or snow | -4 |

| Maintenance of Buses | POINTS |
|---|---|
| Buses have graffiti, litter, seats in disrepair, bus mechanisms (e.g., doors) not functioning properly | -2 |

| Maintenance of Stations | POINTS |
|---|---|
| Stations have graffiti, litter, occupancy by vagrants or vendors, or structural damage | -2 |

| Maintenance of Technology Systems | POINTS |
|---|---|
| Technology systems, including fare collection machines, are not functional, up-to-date, and/or accurate | -2 |

| Maintenance of Sidewalks on Corridor | POINTS |
|---|---|
| Sidewalks in disrepair | -2 |

| Maintenance of Bicycle Lanes on Corridor | POINTS |
|---|---|
| Bike lanes in disrepair | -2 |

DEDUCTIONS

# Low Peak Frequency

**-3 points maximum**

How often the bus comes during peak travel times such as rush hour is a good proxy for quality of service. For BRT to be truly competitive with alternative modes, like the private automobile, customers need to be confident that their wait times will be short and the next bus will arrive soon.

**Scoring Guidelines:** peak frequency is measured by the number of buses observed per hour for each route that passes the highest-demand segment on the corridor during the peak period. The peak frequency deduction is then allocated based on the percentage of routes that have a frequency of at least eight buses per hour in the peak period. If observations cannot be made, frequencies may be obtained through route schedules.

| % Routes With At Least 8 Buses per Hour | POINTS |
|---|---|
| 100% have at least 8 buses per hour | 0 |
| 75% have at least 8 buses per hour | -1 |
| 50% have at least 8 buses per hour | -2 |
| ‹ 50% have at least 8 buses per hour | -3 |

# Low Off-Peak Frequency

**-2 points maximum**

As with peak frequency, how often the bus comes during off-peak travel times is a good proxy for quality of service.

**Scoring Guidelines:** off-peak frequency is measured by the buses per hour of each route passing through the highest-demand segment on the corridor during the off-peak (midday) period. The off-peak frequency score is then determined based on the percentage of all routes that have a frequency of at least four buses per hour during the off-peak period.

| % Routes with at Least 4 Buses per Hour | POINTS |
|---|---|
| 100% of all routes have at least 4 buses per hour | 0 |
| 60% of all routes have at least 4 buses per hour | -1 |
| ‹ 60% of all routes have at least 4 buses per hour | -2 |

# Permitting Unsafe Bicycle Use

**-2 points maximum**

Bicycle use in busways is generally not encouraged, and is particularly dangerous in bus lanes with speed limits greater than 25 kilometers per hour (15 miles per hour) and/or bus lanes with widths less than 3.8 meters 12 feet). If cycling is observed in these conditions, a deduction should be made.

| Permitting Unsafe Bicycle Use | POINTS |
|---|---|
| Cycling permitted in bus lanes with speed limits greater than 25 kilometers per hour (15 miles per hour) and/or bus lanes with widths less than 3.8 meters (12 feet) | -2 |

# Lack of Traffic Safety Data

**-2 points maximum**

Traffic safety data is vital to ensuring that transportation systems operate safely and to evaluating efforts to improve safety. All cities should collect traffic safety data and make this information public so that progress can be tracked.

| Traffic Safety Data Not Collected | POINTS |
|---|---|
| Traffic safety data is not collected | -2 |

# Buses Running Parallel to BRT Corridor

**-6 points maximum**

Bus corridors should be designed to capture as much of the public transportation demand on a corridor to maximize the utility of dedicated transit infrastructure. A significant number of full-sized public buses operating outside of the busway results in difficult transfers, undermines the financial sustainability of the BRT corridor, and leads to less frequent service on the corridor.

| Buses Running Parallel to BRT Corridor | POINTS |
|---|---|
| < 60% of buses operating on corridor use busway | -2 |
| < 40% of buses operating on corridor use busway | -4 |
| < 20% of buses operating on corridor use busway | -6 |

# Bus Bunching

**-4 points maximum**

Bus reliability is critical to improving BRT performance. Bus bunching—when the distance between buses becomes highly uneven—reduces reliability, increases wait times, and contributes to crowding conditions, deteriorating the quality and speed of service.

**Scoring Guidelines:** bus bunching deductions will be made when two buses are seen traveling in the same direction on the same route, one directly behind the other. Observation for this deduction are to be made during the peak hour at the highest demand segment on the corridor.

| Bus Bunching | POINTS |
|---|---|
| Bus bunching observed on corridor | -2 |
| Multiple instances of bus bunching are observed on corridor within an hour | -4 |

# Application to Rail Corridors

The *BRT Standard* was specifically designed by BRT experts to be applied to BRT corridors. However, almost all of the elements in the *BRT Standard* could easily be applied to rail transit corridors (including streetcar, tram, light-rail, and metro) with minimal modification. Using the *BRT Standard* to evaluate rail transit corridors would allow users to assess the general quality of rail transit services and compare them to other transit corridors, including BRT. It could also provide a more standard definition of rapid transit and determine which rail transit corridors meet that definition. The following section briefly describes a preliminary concept of how the *BRT Standard* might be applied to rail transit corridors.

## BRT Basics

The *BRT Standard* defines the BRT basics as a set of elements essential to a service's being called BRT. These elements all aim to minimize passenger delay, thus ensuring the "rapid" component of a bus rapid transit corridor. These same criteria can be applied without modification to rail transit corridors to assess whether they meet a more general definition of rapid transit as well.

## Terminology

The *BRT Standard* often refers to "busways," "BRT," and "buses." When using the BRT Standard to assess rail transit corridors, these should be substituted with "transitways," "rapid transit," and "transit vehicles" throughout the text. The definitions of a corridor would also need to be modified to account for rail.

## Pavement Quality

The *BRT Standard* metric of pavement quality should be modified to evaluate rail quality. ITDP is engaging with rail transit experts who understand how railbeds and tracks are designed for more guidance on this section. In the meantime, the evaluation of the railbed and tracks can be scored based on whether they are designed to a thirty-year life span or not.

## Signaling

The distance between rail vehicles is largely governed by the type of signal system that is used. Better signals can allow for increased headways and improved service. Since BRT corridors are not limited by signal systems, this is not a part of the *BRT Standard*. Ideally, to evaluate rail transit corridors, a separate section would be added to address signal systems. BRTs would automatically score maximum points in this section, since buses are not constrained by signaling systems and can operate at closer spacings than are permitted by most signal systems. ITDP is consulting rail experts to determine how this section might be developed. Until that work is completed, signaling considerations could simply be ignored, as the effects of low-quality signal systems are likely captured by some of the point deductions for operations (e.g., deductions for overcrowding).

## Elements Specific to BRT

Some elements of the *BRT Standard* are more common in BRT corridors. For example, very few metro and light-rail systems offer express, limited-stop, and local services or multiple routes operating on the same corridor. There are, however, prominent rail examples of both, such as the New York City Subway or the Lyon Tramway. These elements provide a higher quality of transit service for any mode and should be retained, even if they seldom result in points for rail systems.

## Grade Separated Systems

Fully grade-separated electric rail transit systems, such as metro, will likely receive maximum points in a number of categories, including Transitway Alignment, Off-Board Fare Collection, Intersection Treatments, Minimizing Emissions, Stations Set Back from Intersections, and Platform-Level Boarding. This is logical, as grade separation removes many of the sources of delay that a transit system might encounter, making them more likely to achieve gold standard.

# Notes

Institute for Transportation & Development Policy

www.itdp.org

Rockefeller Foundation
Innovation for the Next 100 Years

www.rockefellerfoundation.org

BARR FOUNDATION

www.barrfoundation.org

ClimateWorks FOUNDATION

www.climateworks.org

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www.despacio.org

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www.giz.de

ICC
THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

www.theicct.org

UN-HABITAT
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www.unhabitat.org

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WORLD RESOURCES INSTITUTE | WRI ROSS CENTER FOR SUSTAINABLE CITIES

www.wri.org

# BRT Standard Scorecard

| CATEGORY | MAX SCORE |
|---|---|
| **BRT Basics** (PP. 26–37) | **38 (TOTAL)** |
| Dedicated Right-of-Way | 8 |
| Busway Alignment | 8 |
| Off-Board Fare Collection | 8 |
| Intersection Treatments | 7 |
| Platform-level Boarding | 7 |
| **Service Planning** (PP. 38–44) | **19** |
| Multiple Routes | 4 |
| Express, Limited-Stop, and Local Service | 3 |
| Control Center | 3 |
| Located in Top Ten Corridors | 2 |
| Demand Profile | 3 |
| Hours of Operations | 2 |
| Multi-Corridor Network | 2 |
| **Infrastructure** (PP. 45–52) | **13** |
| Passing Lanes at Stations | 3 |
| Minimizing Bus Emissions | 3 |
| Stations Set Back from Intersections | 3 |
| Center Stations | 2 |
| Pavement Quality | 2 |
| **Stations** (PP. 53–57) | **10** |
| Distances Between Stations | 2 |
| Safe and Comfortable Stations | 3 |
| Number of Doors on Bus | 3 |
| Docking Bays and Sub-stops | 1 |
| Sliding Doors in BRT Stations | 1 |

## Minimum Requirements for a Corridor to be Considered BRT

1. At least 3 kilometers (1.9 miles) in length with dedicated lanes
2. Score 4 or more points in dedicated right-of-way element
3. Score 4 or more points in busway alignment element
4. Score 20 or more total points across all five BRT basics elements

| CATEGORY | MAX SCORE |
|---|---|
| **Communications** (PP. 58–59) | **5** |
| Branding | 3 |
| Passenger Information | 2 |
| **Access and Integration** (PP. 60–65) | **15** |
| Universal Access | 3 |
| Integration with Other Public Transport | 3 |
| Pedestrian Access and Safety | 4 |
| Secure Bicycle Parking | 2 |
| Bicycle Lanes | 2 |
| Bicycle-Sharing Integration | 1 |
| **Operations Deductions** (PP. 66–72) | **-63** |
| Commercial Speeds | -10 |
| Peak Passengers per Hour per Direction (pphpd) Below 1,000 | -5 |
| Lack of Enforcement of Right-of-Way | -5 |
| Significant Gap Between Bus Floor and Station Platform | -5 |
| Overcrowding | -5 |
| Poorly Maintained Infrastructure | -14 |
| Low Peak Frequency | -3 |
| Low Off-Peak Frequency | -2 |
| Permitting Unsafe Bicycle Use | -2 |
| Lack of Traffic Safety Data | -2 |
| Buses Running Parallel to BRT Corridor | -6 |
| Bus Bunching | -4 |

**BRONZE**
55–69.9 points

**SILVER**
70–84.9 points

**GOLD**
85–100 points