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1. Introduction

1.1. Background

In November 2011, the Department of Transport (“DoT”), which became Transport for NSW (“TfNSW”) after November 1 2011, commissioned Booz & Company, in association with AECOM, as the Integrated Transport and Land Use (“ITLU”) Technical Advisor for the Sydney Light Rail Strategic Plan (“SLRSP”) for Phase 2. The ITLU technical advisor role is one of seven Technical Advisors (“TAs”) appointed by TfNSW to facilitate the delivery of the SLRSP.

The first stage of Phase 2 was to identify mass transit and access mode options in the three corridors identified in Phase 1 and to conduct a strategic merit test (SMT) of the long list of route options.

Figure 1-1 below summarises the SLR Strategic Plan work program.

![Figure 1-1: Overall Program](image)

The objective of the SMT is to assess at a high level a number of route options to arrive at a shortlist which could be taken to more detailed assessment and demand testing in the second stage.

This document constitutes the final report on the route options identification task and presents the findings of the SMT.

1.2. Strategic Context

1.2.1. Transport for a Global City

As with most international cities, Sydney has been facing increasing road congestion over the last 10 years. In the absence of further development in public transport, the current levels of car and bus congestion on the city’s roads are expected to increase.
At present, fixed public transport infrastructure in Sydney is based on the CityRail heavy rail network, complemented by an extensive network of bus routes and a single light rail route running from Central to Lilyfield, with the Government committed to an Inner West light rail extension to Dulwich Hill.

Heavy rail is well suited to long distance (over 10 kilometre) journeys, or shorter journeys which originate close to railway stations. Many areas of inner Sydney (inside 10km from the CBD) are not served by the heavy rail network. These areas are currently best served by the bus network.

To remain competitive as a global city, Sydney CBD needs to expand the services based economy of the CBD (in the area referred to as ‘Global Sydney’). Global Sydney is currently a significant employment centre, with the majority of jobs provided within the Sydney CBD.

### 1.2.2. Growth needs efficient transport

CBD employment is expected to grow by 30% to 2036 (BTS, 2009a). The resident population in Global Sydney is expected to grow by a similar percentage over the same time period (BTS, 2009b). The impact of these increases is anticipated to generate significant strain on the transport network unless public transport capacity and mode share is increased.

A key element of the inner city public transport network is the bus network. The existing bus network caters for 45,000 commuter journeys to Sydney Inner Statistical Local Area (which corresponds to Sydney CBD) most of which take place in the 2 hour AM peak (Australian Bureau of Statistics, 2006). To cater for the volume of passenger journeys, over 2,000 bus movements are scheduled (on over 190 routes) into Sydney CBD in the peak two hours (STA, 2010). Significant congestion of bus lanes in Sydney CBD is caused by this quantum of bus operations (coupled with peak-time private vehicle and taxi movements).

Bus network efficiency (and capacity) has been improved in recent years by:

- Reducing the number of services that operate the “full route” through the CBD;
- Increased through routing of buses that do not terminate within the CBD (Metro buses);
- Implementing a “pre-paid” boarding policy within the CBD; and
- Expanding the network of full time bus lanes.

### 1.2.3. Efficient Bus Operations

Recorded bus travel times in George Street vary significantly from published timetables. In the weekday morning peak, northbound buses experience an average delay of over 6 minutes. In the off peak period, this delay is reduced to about two minutes. These delays occur despite the introduction of bus lanes along most of George Street. Buses experience delays at intersections where left turning traffic blocks the bus lane while it waits for red signals and then for pedestrians crossing during the green phase (BTS, 2011a).

In addition to these factors, the operational needs of the bus network require many vehicles to lay-over in the CBD. This generates a significant impact on the amenity of streets around bus interchanges.
Opportunities for resolving these issues that have been considered (and, in some cases, implemented) include changing the vehicle fleet to include more high-capacity vehicles (articulated buses) and through routing some services to reduce layovers (MetroBus).

The number of bus movements on some CBD streets seems to have reached a tipping point where they cause congestion (of dedicated bus lanes). This congestion is, in part, caused by inefficiencies inherent in bus vehicle design, including:

- The carrying capacity of typical 14m buses, which comprise a high proportion of buses using these lanes;
- Long dwell time associated with loading characteristics (single door entry); and
- Driver characteristics (individual bus driver behaviour resulting in different acceleration, deceleration, turning and sweep path characteristics for each vehicle).

These characteristics are very difficult to overcome using buses due to technical factors of bus design that influence their maximum length and how they can be operated.

This results in many more public transport vehicles using the CBD road network than is absolutely necessary. For example, in the peak one hour, the University of NSW is served by 41 express bus services from CBD Stations (37 on Route 891 to Central and four on Route 890 to Circular Quay). These services can cater for around 2,500 passengers in each direction (assuming an average capacity of 60 people per vehicle).

A similar number of passengers (over the peak one hour) could be served using just eight light rail vehicles (assuming a standard 44 metre long vehicle with a capacity of approximately 300 people per vehicle). Using fewer vehicles for the same task may lessen the impact on other road users at traffic signals (particularly cross movements). Light rail vehicles may be faster to load and unload passengers, further improving travel time, resource utilisation and congestion for other vehicles.

### 1.2.4. Potential Opportunities and Benefits of Light Rail

The core objective of this study is to test hypotheses related to increasing public transport efficiency in corridors of inner Sydney that have a high volume of bus movements and have counter peak flows (such as through the CBD and to UNSW and USyd.). The specific hypotheses are that light rail vehicles will be more efficient than buses because light rail vehicles:

- Carry a larger number of passengers given an equal amount of road space;
- Can provide an enhanced customer experience;
- Have faster loading and unloading times; and
- Can provide journey time savings.

The possibility of additional light rail routes present transformational development opportunities and potential benefits in Sydney:

- Light rail vehicles (having greater capacity than buses) can replace whole bus routes and minimise congestion caused by large numbers of buses on specific corridors;
- Supporting dense land use in the CBD and along inner city corridors will help to transform Sydney to a greater extent than other surface public transport improvements can;
Further urban renewal (e.g. improvement in streetscape) and additional transit oriented developments (TODs) can be delivered with the future land use change expected;

- Dedicated priority running can be given at grade where appropriate to improve line speeds and reliability (making journey times shorter and more predictable for passengers);
- Integrated ticketing will reduce the inconvenience and monetary cost for customers using and interchanging between public transport services; and
- Parking policy controls have already been enhanced to support the role of public transport and encourage more efficient use of road space.

However, the development of additional light rail routes in Sydney present both planning and implementation challenges:

- The overall urban transport network has been developed primarily as a heavy rail and road network for the last 60 years, where some streets in the CBD have developed multiple vehicular entry points into buildings and parking stations at regular intervals in addition to bus stops; furthermore, car parking, taxis and bus access all cause significant congestion in the CBD and on strategic corridors;
- Use of kerbside space (for vehicular driveways, bus stops and other necessary infrastructure) make retrofitting light rail infrastructure difficult;
- Sections of the transport network are approaching reliable operating capacity at peak hours;
- The strategic transport network (road, rail, bus) is not serving peak hour and off-peak travel demands effectively or efficiently;
- There is no rail alternative in many suburbs of Sydney; and
- The legacy of a very large CBD focussed bus network which serves direct trips to the CBD.

1.3. Data Sources

There have been numerous studies into the planning and development of light rail in Sydney over the last 15 years. In this phase of the SLR Strategic Plan project, we have been asked to build on the most relevant recent work which have already been featured as key inputs into Phase 1 of the SLR Strategic Plan program.

Specifically, we have consulted the following key data sources for the analysis conducted for this report:

- Transport for NSW (2011) (prepared by Parade Consulting), Sydney Light Rail Extensions: Base Case Internal Discussion Paper, November;
- Transport for NSW (2011) (prepared by Parsons Brinckerhoff), CBD Light Rail Report, February;
- Transport for NSW (2011) (prepared by AECOM), Sydney Light Rail Strategic Plan – Strategic Needs Assessment, October;
- City of Sydney (2011), *Sydney Light Rail Strategic Plan: Initial Inputs*, November; and

A number of the references listed above provide a summary of over 15 years of light rail planning in the study area and therefore form a strong basis for identification of light rail route options. Significantly, it is considered that within the study area every viable alternative route alignment worthy of consideration has been previously documented in one or more of the documents.

In addition to the documentation above, we have also drawn on the extensive expertise and knowledge of the client project team at TfNSW to provide input into this report, including the following papers:

- Transport for NSW (2010), *Sydney Light Rail Extension – Stage 1 Inner West Extension: Product Definition Report – Final report*, July; and

A list of the references consulted is provided in the bibliography in Chapter 5.

1.4. **Approach**

The methodology for the analysis undertaken in this report is summarised as follows:

1. Review the recent and relevant documents to identify route options;
2. Identify any other route options outside the existing documents;
3. Summarise the long list of route options;
4. Review the existing policy aims and objectives at TfNSW for the SLR Strategic Plan;
5. Develop evaluation framework from the policy aims and objectives;
6. Develop evaluation criteria for the SMT;
7. Conduct a SMT of the long list of route options – by passing the options in (3) through the criteria in (6);
8. Review results and summarise key aspects of each option against the strategic objectives of the study; and
9. Identify the shortlist of options for further assessment in the next stage.
1.5. **Study Area**

The NSW Government has made a series of commitments related to building a light rail network:

- Incorporate existing light rail services from Central to Lilyfield into the My Zone ticketing system;
- Ensure that light rail is part of the proposed Electronic Ticketing System;
- Extend the existing light rail services in the inner west from Lilyfield to Dulwich Hill;
- Build light rail in the Sydney CBD subject to feasibility;
- Conduct a feasibility study to extend the light rail network from Central Railway Station to Sydney University; and
- Conduct a feasibility study to extend the light rail network from Central Railway Station to University of Sydney.

The last three commitments have informed the study area for the Sydney Light Rail Strategic Plan as the priorities for a potential future light rail network.

Booz & Company and AECOM were asked to identify and consider possible route options in three transport corridors:

- The CBD corridor;
- The University of Sydney (“USyd”) corridor; and
- The University of New South Wales (“UNSW”) corridor.

The three corridors, shown in Figure 1-2, are influenced by a broader area of interest (indicated in red), which was defined for the purpose of understanding transport demand and land uses that could affect mass transit solutions in the three corridors announced by the Government.
As described by TfNSW (2011c), “the study area contains the greatest concentration of population and jobs in Australia, requiring transport services that are critical locally and nationally.” Furthermore, additional strong economic growth is expected from the study area, “for example, Randwick is expected to experience 50% growth in industry output between 2011 and 2036, equating to an extra $333 million per annum”.

The Sydney CBD is the biggest employment centre in New South Wales and also generates trips for shopping, entertainment and tourism. The study area also contains several major trip generators including three of Australia’s major universities (the University of NSW, the University of Sydney and the University of Technology, Sydney) as well as two major hospitals in Sydney (the Royal Prince Alfred Hospital and the Prince of Wales Hospital). In addition, Moore Park in the UNSW corridor is a major entertainment and sporting precinct, featuring the Sydney Football Stadium and the Sydney Cricket Ground.
1.6. Structure of the Report

The remainder of the report is structured as follows:

- Chapter 2 identifies the long list of route options;
- Chapter 3 develops the assessment criteria for the SMT and presents the results of the SMT and the resultant shortlist of route options;
- Chapter 4 presents the conclusions and recommendations drawn; and
- Chapter 5 contains the bibliography.
2. **Identification of Route Options**

2.1. **Overview**

This chapter identifies the strategic transport issues to be solved and presents the definitional framework through a review of the existing work. In reviewing work completed to date, the study team has determined that all route options likely to be feasible have been identified in the previous work. This is due in part to the limited number of alignments available and scope of the study area.

The chapter concludes with the long list of options for testing in the SMT.

The identification of route options was driven by a process of:

- Engaging with internal stakeholders (with significant knowledge and experience) to understand the issues being addressed and previous work undertaken;
- Reviewing the significant wealth of previous work;
- Identifying core (base case) assumptions; and
- Identifying a long list of options likely to meet the SMT criteria.

2.2. **Issues Identification and Definitional Framework**

2.2.1. **Strategic Issues Identification**

There are many benefits that could arise from the development of a light rail network in Sydney. However, for the Strategic Merit Test (SMT), it is the core strategic issues to be addressed that are of most importance. Detailed evaluation of other benefits occurs at a later phase of the assessment process.

As the review of the existing work in Section 2.3 shows, the core issue to be addressed by a light rail network concerns congestion of Sydney CBD bus movements. This congestion is caused partly by the high volume of bus (vehicle) movements required to serve current passenger demands. On some corridors, this leads to multiple buses operating on the same or similar routes, bunching behind each other at traffic lights because they are operating under very short headways (e.g. under four minutes).

Each bus service has its own acceleration, braking and stopping profile based on driver behaviour, creating inefficient use of the road system.

A light rail network could ease this problem due to the different (more efficient) boarding, passenger loading and more consistent driver behaviour resulting in fewer vehicles and more predictable movements.
In order to have a significant impact, the light rail route needs to be long enough to fully meet some passengers travel needs, so the passengers are encouraged to switch modes. Therefore, the SMT is focused on the three high demand corridors, namely:

- The CBD corridor: Central Station – Circular Quay;
- The USyd corridor: Central Station – University of Sydney & Royal Prince Alfred Hospital; and
- The UNSW corridor: Central Station – University of NSW & Prince of Wales Hospital.

### 2.2.2. Definitional Framework

The overall track capacity (inclusive of the line speed of the service) can be disaggregated and quantified along the following dimensions:

- **Corridor:** A linear geographic band defined by existing and forecasted travel patterns (e.g. CBD to University of Sydney).
- **Route:** The general route within a selected corridor, which may not identify all streets that the route passes through (e.g. Broadway and Parramatta Road).
- **Mode:** The term used to distinguish substantially different transport vehicles and associated technology (e.g. light rail or bus).
- **Grade:** The grade of the route alignment – i.e. at surface level, sub-surface or deep underground; and
- **Priority:** The traffic management measures which give light rail modal priority when operating in multi-modal environment (e.g. full grade separation (such as tunnel), signal priority (at traffic lights), lane priority (a dedicated lane within the street)).

We have used this definitional framework in defining options for the SMT. The route options for the assessment in the SMT are not necessarily whole standalone options. In some cases, there may be standalone component sections which could be used to form whole standalone options at a later stage.

### 2.3. Review of Existing Work

#### 2.3.1. Historical Growth in Travel Demand

Growth in weekday travel demand in the past 10 years across the Sydney Statistical Division has increased by 0.8% pa, slightly less than population growth, which is approximately 1.1% pa (BTS, 2011b).

Of the public transport options, train displays the largest absolute and proportional increase in mode share over the ten-year period, although strong growth in bus travel is also evident. Growth in public transport usage has been strongest in the last 5 years with rail usage growing at 3.1% p.a. and bus at 2.2% p.a. where growth in public transport usage has been strongest close to the Sydney CBD (BTS, 2011b).

Within a 10km radius of the study area, between 2011 and 2036, population and employment is forecast to grow by 20 and 22 per cent respectively. The growth in population and employment will consequently cause travel demand to grow. This will result in increased pressure on travel to Sydney CBD, resulting in need to consider high capacity public transport options.
Table 2-1: Growth in travel demand and population in Sydney Statistical Division

<table>
<thead>
<tr>
<th>Travel Demand Characteristics</th>
<th>2001/02</th>
<th>2009/10</th>
<th>Growth ('000)</th>
<th>AAGR 01/02-09/10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persons ('000)</td>
<td>4,067</td>
<td>4,437</td>
<td>370</td>
<td>1.1%</td>
</tr>
<tr>
<td>Total Travel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trips Av Weekday ('000)</td>
<td>15,207</td>
<td>16,171</td>
<td>964</td>
<td>0.8%</td>
</tr>
<tr>
<td>Total travel ('000 kms)</td>
<td>127,560</td>
<td>133,557</td>
<td>5,997</td>
<td>0.6%</td>
</tr>
</tbody>
</table>

Source: BTS (2011b)

### 2.3.2. Existing Travel Demand

Table 2-2 shows the relative mode split for the three main motorised modes originating across the Sydney Statistical Division (SD) and within a 10 kilometre radius of the CBD.

Table 2-2: Relative Mode Split of Motorised trips originating in Sydney SD and 10km of the Study Area to all destinations

<table>
<thead>
<tr>
<th>Year</th>
<th>Data source</th>
<th>Origin</th>
<th>Car</th>
<th>Bus</th>
<th>Train</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>Journey to Work (JTW)</td>
<td>Sydney Statistical Division (SD)</td>
<td>76%</td>
<td>7%</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10km radius of the CBD</td>
<td>65%</td>
<td>16%</td>
<td>19%</td>
</tr>
<tr>
<td>2005/06</td>
<td>Household Travel Survey (HTS)</td>
<td>Sydney Statistical Division (SD)</td>
<td>77%</td>
<td>7%</td>
<td>16%</td>
</tr>
<tr>
<td>2009/10</td>
<td>Household Travel Survey (HTS)</td>
<td>Sydney Statistical Division (SD)</td>
<td>74%</td>
<td>8%</td>
<td>17%</td>
</tr>
</tbody>
</table>

Source: BTS (2011b) and ABS (2006)

Note (1): ‘Car’ includes driver and passenger trip numbers.

In 2009/10, car trips declined to about 75 per cent, showing a switch from car to public transport travel with an increase in bus and rail mode share. The data showed trips originating within 10 kilometres of the CBD had a greater tendency to travel by bus and rail than those for the wider Sydney area.

Public transport to Sydney CBD destinations has a greater mode share than to all destinations in the study area as shown in Table 2-3 below.

Table 2-3: Relative Modal Split of Motorised trips originating in Sydney SD and 10km of the CBD to Sydney CBD destinations

<table>
<thead>
<tr>
<th>Year</th>
<th>Data source</th>
<th>Origin</th>
<th>Car</th>
<th>Bus</th>
<th>Train</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>Journey to work</td>
<td>Sydney SD</td>
<td>21%</td>
<td>26%</td>
<td>53%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10km radius of the CBD</td>
<td>22%</td>
<td>40%</td>
<td>38%</td>
</tr>
</tbody>
</table>

Source: ABS (2006)
For trips to the CBD from within 10 kilometres of the CBD, 40% are made by bus and 38% by train, with only 22% by car.

Figure 2-1 shows the mode share for journeys to work by bus and rail, focusing on the corridors in the study area, including the Sydney CBD.

**Figure 2-1: Rail and bus mode share for journeys to work**

A strong rail mode share is correlated with existing rail lines and stations. Bus is the dominant mode where there is no rail option. In terms of the study area, bus demand is particularly high in the Inner West and the South East of Sydney, where there is no rail.

A high number of bus services carry significant levels of demand into the Sydney CBD during the peak hour, resulting in delays to passengers on road-based public transport.

Figure 2-2 overleaf shows the volume of bus movements through inner Sydney in the AM peak period (arriving into the CBD between 7am and 9am). This highlights the importance of bus services in providing public transport coverage on corridors not serviced by rail.

Generally speaking, most major road corridors, as well as many secondary road corridors, are well served by existing bus services demonstrating the high dependence across Sydney’s inner suburbs on bus services to meet demand for public transport.
Figure 2-2: 2011 AM Peak Period Bus Volumes

Source: BTS / State Transit Authority (STA)

Figure 2-2 highlights the number of buses entering Sydney CBD from various directions. The Anzac Parade and Parramatta Road corridors are two of the five busiest in terms of bus movements. Coupled with the close proximity of key attractors (UNSW & USyd), these corridors are likely to generate high passenger demand for short journeys (more so than the north or western corridors) in the short term.

Both have large destinations (a university and hospital in each corridor) that generate significant patronage between that point and the CBD (particularly connecting to metropolitan rail services). This contrasts with the north-east, north-west and western corridors all of which have a more gradual increase in passenger demand over longer corridors (which are more difficult to supplement with light rail).

The number of students from University of Sydney and University of NSW living within selected travel zones in inner Sydney is shown in Figure 2-3 below.
The figures above highlight the regional demand for travel to inner city universities, particularly to the University of NSW. This implies that connection to the regional transport (heavy rail) network will be essential for attracting passengers onto the light rail network. The figures also highlight the density of student residences in the Sydney CBD.

2.4. **Key Assumptions**

A range of assumptions are required in order to ensure the SMT is logical and compares options appropriately and logically. These include:

- **Network: A CBD North-South link**
  
  - The options discussed in this report are sub-components of a network. The core assumption to the network is that a north-south spine through the CBD will be required to distribute passengers to the whole CBD without forcing them to transfer to another service.
  
  - It is also assumed that the CBD spine would not be viable as a standalone proposition (i.e. it remains unconnected to the network), as transfers would be forced (at the southern end) in order to reach any significant suburban destination.
- In essence, the SMT is being used to determine which of the CBD and suburban route options would most strongly meet the strategic objectives. The strongest candidate routes will then proceed to the next phase of analysis and assessment.

- **Mode**
  - The choice of mode (light rail, bus, tram, monorail or other) for the purpose of the SMT has been assumed to be light rail but will be more fully investigated in subsequent stages of the assessment process.
  - Bus routes that operate parallel to the light rail corridors identified could be replaced, rerouted or retained, depending on the extent to which the light rail network caters for the passenger demand.
  - It has been assumed that light rail would be most cost effective on very busy corridors, in a manner that will cater for a high volume of passengers. The implied result would be fewer public transport vehicles entering the CBD while catering for a larger volume of passengers.

- **Vehicle Priority**
  - It has been assumed that a high degree of priority (and physical separation) will be provided to light rail vehicles operating in any corridor. If such an allowance is technically difficult, this is noted through the SMT. Where separation may be impossible, the degree to which physical segregation of the light rail vehicles can be achieved also influences the SMT.

- **Customer Requirements**
  - We have assumed that any option would reflect best practice such as:
    - Infrastructure would be constructed to enable seamless interchange wherever possible;
    - The vehicles procured would be modern low floor vehicles compliant with the Commonwealth Disability Discrimination Act 1992 (DDA); and
    - Network would have priority systems and measures installed to ensure the best possible operating speeds and reliability is achieved.

- **System Performance Parameters**
  - In the absence of future system performance parameters, we have assumed that the system performance parameters for the extension from the Inner West to Dulwich Hill would be applicable to the three corridors.

- **Non-infrastructure solutions**
  - It has been assumed that an integrated fare structure and electronic ticketing will be in place to facilitate multi-modal travel and enabling ease of interchange.
  - It has also been assumed that street parking and vehicular entry into buildings would be managed to give priority to the light rail operations.
2.5. Identification of previously investigated route options

The route options identified have been separated into two main groups:

- CBD Options; and
- Suburban Options.

2.5.1. CBD Options

Options for light rail in the CBD corridor of Sydney can be identified from a variety of recent reports. Those included in this SMT are:

- Two north-south options between Circular Quay to Central Station:
  - George Street; or
  - Sussex Street; and
- A Barangaroo alignment: Hickson Road to Circular Quay

The scope of the current study includes the George Street and Sussex Street alignments with Barangaroo as an extension on the basis that other options (such as Pitt Street and Castlereagh Street) have been ruled out (as less optimal) in previous analyses (TfNSW 2011a, TfNSW 2011b, CoS 2006).

The CBD light rail options have had the most detailed engineering analysis undertaken looking at constraints such as road dimension, gradients, vehicle access and public domain (TfNSW, 2011a). In summary, the George Street corridor has been found to have the least engineering constraints of any of the CBD corridors, as follows:

- **Corridor Width**: George Street is as narrow as 17 metres at some points but generally is the widest CBD route (up to 31 meters) offering best option for pedestrian amenity. It is worth noting that Castlereagh and Pitt Streets are particularly narrow and these options would severely impact upon pedestrian amenity through reduced footpath widths.

- **Gradient**: The George Street option is entirely within a 7% gradient, whereas all other options have steeper gradients. In the case of Sussex Street and the Barangaroo extension, there are likely to be significant challenges in achieving disabled access standards due to the gradients and in some cases cross-fall.

- **Vehicle Access**: Vehicle access is a consideration as it adds potential new conflict points with light rail tracks with vehicles turning or queuing in front of light rail vehicles. George Street has the least vehicle access points (15) compared with 47 in Hickson Road along the Barangaroo alignment and 49 in Sussex Street. It is worth noting for comparative purposes that Pitt Street has 36 vehicle access points while Castlereagh Street has 53.

- **Public Domain**: George Street is the only route which has a potential positive public domain spin-off with the light rail being a potential catalyst for the pedestrianisation of George Street (in line with City of Sydney’s objectives). By comparison, Castlereagh and Sussex Streets and the Barangaroo alignment may all require tree removal. The Pitt Street option and Barangaroo alignment would both impact on existing areas of high pedestrian amenity – although it is considered that appropriate detailed design could minimise any negative impact.
2.5.2. **Suburban Options**

A range of ‘suburban’ corridors have also been identified from based largely on synthesis of previous studies:

- **University of NSW Corridor**: Central Station to UNSW via Anzac Parade; and
- **University of Sydney Corridor**: Central Station to University of Sydney.

Of the non-CBD corridors, little engineering analysis has been undertaken in past studies (CoS, 2011). The following sets out the high level engineering constraints associated with each of these corridors gleaned from knowledge of the area and past reports (TfNSW, 2011f):

Engineering constraints arising from the **UNSW Corridor** largely arise from topographic issues between Anzac Parade and Central Station and the congested nature of the road network (predominantly made up of narrow residential streets). Various techniques to address these issues include property acquisition, tunnelling and re-grading the street. Property acquisition adds additional complexity and cost (financial and social) to the project. Whilst a more community-sensitive approach may be tunnelling underneath residential area, it has a more significant financial cost (though costs are the subject of analysis in subsequent assessment phases – not in the SMT).

The major engineering constraint associated with the **University of Sydney Corridor** is the need for a seven metre wide light rail corridor along Broadway and City Road. The key issue being that the bus priority lanes would most likely need to be retained (meaning the seven metre corridor must come from the six other existing traffic lanes).

The likely need to retain the bus priority lanes is closely linked to the length of light rail considered in the option as only a couple of the 22 bus routes in the corridor could be replaced by a light rail route that terminates around Missenden Road. The alternative to encroaching on existing traffic lanes would be land acquisition or tunnelling. Both of which are unlikely to be acceptable in this corridor on the basis of a relatively short route (and moderate demand) between Central station and the University of Sydney.

2.6. **Long List of Options**

Several documents were reviewed to identify the key corridors and potential routes within the study area. The seven main documents reviewed are listed in Table 2-4 below.

**Table 2-4: Documents reviewed to establish options**

<table>
<thead>
<tr>
<th>Documents Reviewed</th>
<th>Author</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Rail Programs 2011 – Literature Review</td>
<td>Transport for NSW</td>
<td>November 2011</td>
</tr>
<tr>
<td>Sydney Light Rail Strategic Plan: Initial Inputs</td>
<td>City of Sydney</td>
<td>November 2011</td>
</tr>
<tr>
<td>CBD Light Rail Report</td>
<td>Parsons Brinckerhoff</td>
<td>February 2011</td>
</tr>
<tr>
<td>Sydney Light Rail Extension – CBD Prelim Technical Feasibility Study Report</td>
<td>GHD</td>
<td>September 2011</td>
</tr>
<tr>
<td>Randwick Light Rail Pre-Feasibility Study</td>
<td>GHD</td>
<td>September 2011</td>
</tr>
<tr>
<td>Sydney Light Rail Extensions Base Case Internal Discussion Paper</td>
<td>Parade Consulting</td>
<td>November 2011</td>
</tr>
</tbody>
</table>
Figure 2-4 overleaf illustrates the route options which emerged from a review of the documents above.

The assessment presented in each document facilitated the identification of route segments that could be included in the SMT. A series of filters were applied to the list of options that could be included to focus on those that would meet the strategic issues and transport needs previously identified. These filters included elimination of route options that:

- Do not serve a CBD Station (such as Central, Circular Quay or Town Hall) and one of the other key destinations (another CBD Station, Barangaroo, University of New South Wales or University of Sydney);
- Use streets previously determined to be too narrow or steep; or
- Would impose significant adverse impact on existing urban fabric of significance (such as heritage areas).

The route options to be tested in the SMT are summarised in Table 2-5 and shown in Figure 2-5.

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Option</th>
<th>Route options to be tested in the SMT</th>
<th>Also Serves</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBD</td>
<td>A</td>
<td>Central Station – Circular Quay via George St</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Circular Quay – Barangaroo via Hickson Road</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>Central Station – Barangaroo via Sussex St &amp; Hickson Rd</td>
<td>The Rocks</td>
</tr>
<tr>
<td>USyd</td>
<td>D</td>
<td>Central Station – RPA Hospital via Parramatta Rd</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>Central Station – RPA Hospital via City Rd</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>Central Station – RPA Hospital via Cleveland St &amp; Lee St</td>
<td></td>
</tr>
<tr>
<td>UNSW</td>
<td>G</td>
<td>Central Station – Todman Ave via Green Sq &amp; Elizabeth St</td>
<td>Waterloo, Zetland &amp; Kensington</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>Central Station – Todman Ave via Surry Hills</td>
<td>Surry Hills, Zetland &amp; Kensington</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>Central Station – Dacey Ave via Moore Park &amp; Surry Hills</td>
<td>Surry Hills &amp; Moore Park</td>
</tr>
<tr>
<td></td>
<td>J</td>
<td>Central Station – Dacey Ave via Tunnel</td>
<td>Surry Hills (Tunnel) &amp; Moore Park</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>Central Station – Dacey Ave via Oxford St</td>
<td>Darlinghurst &amp; Moore Park</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>Town Hall Station – Dacey Ave via Anzac Pde</td>
<td>Darlinghurst &amp; Moore Park</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>Central Station – UNSW via Anzac Pde</td>
<td>Kensington &amp; Kingsford</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Central Station – PoW Hospital via High Street</td>
<td>Kensington &amp; Prince of Wales Hospital</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>Central Station – PoW Hospital via Alison Rd</td>
<td>Randwick &amp; Prince of Wales Hospital</td>
</tr>
</tbody>
</table>
Figure 2-4: Previously investigated route options

Source: Base data copyright LPMA 2011 with AECOM and Booz & Company analysis of various reports (2011)
Figure 2-5: Route options for SMT

Legend

CBD Corridor Routes
A: Central to Circular Quay (George St)
B: Circular Quay to Barangaroo (Hickson Rd)
C: Sussex St & Hickson Rd

USYD Corridor Routes
D: Broadway & Parramatta Road
E: Broadway & City Rd
F: Cleveland St & Lee St

UNSW Corridor Routes
G: Waterloo, Zetland & Kensington
H: Surry Hills, Zetland & Kensington
I: Surry Hills & Moore Park
J: Surry Hills (tunnel) & Moore Park
K: Central, Darlinghurst & Moore Park
L: Town Hall, Darlinghurst & Moore Park

Southern Section
M: Kensington & Kingsford
N: Kensington & Prince of Wales Hospital
O: Randwick & Prince of Wales Hospital

Potential future extension

Source: Base data copyright LPMA 2011 with AECOM and Booz & Company analysis (2011)
3. Strategic Merit Test

3.1. Introduction

This chapter describes the policy context of the SMT and the development of the mechanics for the SMT (including the evaluation criteria). It also presents the results of the SMT.

3.2. Policy Context

3.2.1. Policy Framework

The policy context which provides the objectives of the project can be related to the three levels of government in Australia (TfNSW, 2011g):

- Australian Government
  - COAG – National criteria for cities;
  - National Urban Policy and Sustainable Population Strategy;
  - Infrastructure Australia’s documentation (Infrastructure Australia, 2011);
- NSW State Government
  - The new State Plan: NSW 2021;
  - Existing land use forecasts and policies;
- Relevant Local Government - Inner Area LGAs (including the City of Sydney and Randwick):
  - Sustainable Sydney 2030;
  - The Randwick City Plan; and
  - Other strategic plans and LEPs.

3.2.2. Overarching State Objectives

The development of light rail routes and its associated transport infrastructure and services in Sydney should clearly support the State’s objectives and be consistent with both the State’s strategic priorities and national infrastructure priorities.

Through the publication of the State Plan, NSW 2021 in September 2011, the current State Government has developed clear goals for NSW:

1. Improve the performance of the NSW economy;
2. Rebuild State finances;
3. Drive economic growth in regional NSW;
4. Increase the competitiveness of doing business in NSW;
5. Place downward pressure on the cost of living; and
6. Strengthen the NSW skill base.
For the transport sector, the goals are related to improving the quality of services:

1. Reduce travel times;
2. Grow patronage on public transport by making it a more attractive choice;
3. Improve customer experience with transport services; and
4. Improve road safety.

Developing the right transport infrastructure will be a major contributor to achieving these goals in the defined light rail study area, in particular, growing patronage on public transport will ultimately help to ease road congestion as people switch from car to public transport which, in turn, would help to reduce travel times for those who have to use road transport such as cars and buses.

Also, since the establishment of Transport for New South Wales, there has been a concerted focus to ensure that the customer needs are taken into consideration in the development of new projects and new services. The provision of transport services need to provide a positive customer experiences which aspire to levels of continuous improvement.

The following section describes the policy aims which flow from the policy context and how the policy aims translate into project objectives and ultimately evaluation criteria for the SMT.

### 3.3. Policy Aims and Objectives

From the above overarching state objectives, TfNSW developed a set of broad policy aims based on the following policy areas:

- Customer Experience
- Productivity
- Sustainability
- Liveability

The above policy aims were distilled into more detailed policy aims and project objectives. For example, the structure of Customer Experience policy aims and project objectives was as follows (TfNSW, 2011g):

**Customer Experience**

- Deliver an accessible & legible transport service
  - Accessible to all (DDA compliant);
  - Legible (i.e. intuitive to use);
  - Easy to use;
  - Service & network integration;
- Grow patronage on public transport by making it a more attractive choice
  - Reliability;
  - Frequency;
  - Travel time;
  - Comfort;
 Deliver safe & secure transport
- Prevent/reduce opportunity for & incidence of crime;
- Design in personal security.

TfNSW then analysed how light rail can contribute to achieving the project objectives. For example, DDA accessibility to light rail could be achieved by having low floor vehicles, although this would not be a significant differentiator between route options on the basis that any new route is likely to be serviced by low floor vehicles.

Table 3-1 overleaf outlines the overall objectives framework, covering TfNSW’s policy area, policy aims, project objectives and how light rail outputs can contribute to the achieving the objectives.
<table>
<thead>
<tr>
<th>Customer Experience</th>
<th>Policy Aims</th>
<th>Policy Objectives</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Optimise the customer experience through the provision of a transport system that is legible, easy to use and easy to access (CE1)</td>
<td>Accessible to all (DDA)</td>
<td>Low floor, no steps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Legible</td>
<td>Visible system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Service &amp; network integration</td>
<td>Easily identifiable stops</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Easy to use</td>
<td>Real time information</td>
</tr>
<tr>
<td></td>
<td>Grow patronage on public transport by making it a more attractive choice (CE2)</td>
<td>Reliability</td>
<td>Priority/segregation/right of way</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Travel time</td>
<td>Vehicles specification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency</td>
<td>Passenger facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Comfort</td>
<td>New system</td>
</tr>
<tr>
<td></td>
<td>Deliver safe &amp; secure transport that prevents/reduces opportunity for &amp; incidence of crime (CE3)</td>
<td>Prevent/reduce opportunity for &amp; incidence of crime</td>
<td>Integrated with surrounding land use/urban design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design in personal security</td>
<td>Application of &quot;Crime Prevention Through Environmental Design&quot; (CPTED) Principles</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Productivity</th>
<th>Policy Aims</th>
<th>Policy Objectives</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deliver transport infrastructure and services in a way that best integrates with the broader urban context, including land use, infrastructure, demand and opportunities, (P1)</td>
<td>Land use, social &amp; economic infrastructure considered &amp; integrated with transport</td>
<td>Catalyst for land use change</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Take whole of project approach</td>
</tr>
<tr>
<td></td>
<td>Improve the efficiency of urban transport infrastructure by maximising the return on existing and new infrastructure (P2)</td>
<td>Maximise the return on existing &amp; new infrastructure</td>
<td>Increases capacity of road infrastructure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ensure full use of all resources</td>
<td>Heavy rail focus on longer distance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Redeployment of buses</td>
</tr>
<tr>
<td></td>
<td>Support economic activity and competitiveness by improving access to existing and future employment, education, tourism and key centres, (P3)</td>
<td>Employment growth</td>
<td>Legible system/easy to use</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tourism &amp; visitation</td>
<td>Perception of LRT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Atrractiveness of tertiary education to international students</td>
<td>Serves key destinations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sustainability</th>
<th>Policy Aims</th>
<th>Policy Objectives</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Protect &amp; sustain our natural environment, and sustainable development and refurbishment of our built environment (S1)</td>
<td>Support sustainable development</td>
<td>Supports TOD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refurbishment of built environment</td>
<td>Catalyst for regeneration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Preserve biodiversity/ecological</td>
<td>Brownfield development</td>
</tr>
<tr>
<td></td>
<td>Reduce greenhouse gas emissions &amp; improve air quality by reducing transport related pollution (S2)</td>
<td>Reduce transport related pollution</td>
<td>Urban outcomes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low noise/dust impact</td>
</tr>
<tr>
<td></td>
<td>Increase resilience to climate change &amp; manage energy use sustainably (S3)</td>
<td>Reduce dependence on private vehicles</td>
<td>Electric power</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduce vulnerability to oil price increases</td>
<td>No vehicle emissions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Potential use of renewable energy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Livability</th>
<th>Policy Aims</th>
<th>Policy Objectives</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Support increased amenity &amp; liveability, improve the quality of the urban domain and mitigate corridor impacts. (L1)</td>
<td>Improve the quality of the urban domain</td>
<td>Reduce reliance on buses &amp; delivers greater efficiency in roadspace use</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mitigate corridor impacts</td>
<td>Interchange design</td>
</tr>
<tr>
<td></td>
<td>Support accessible and affordable living choices by increasing access to high quality public transport services (L2)</td>
<td>Increasing access to high quality public transport services</td>
<td>Extend PT catchment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Increase housing opportunity in existing PT catchment (TOD)</td>
</tr>
<tr>
<td></td>
<td>Support community wellbeing and improve public health outcomes (L3)</td>
<td>Improve public health outcomes</td>
<td>Increases PT use, delivers opportunities for walking &amp; cycling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enhance access to cultural, sporting &amp; recreational activity</td>
<td>Access to range of facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Redress disadvantage</td>
<td>Hours/frequency</td>
</tr>
</tbody>
</table>
3.4. Criteria for SMT

The SMT criteria relate to the specific strategic objectives of the government with regards to the transport system. The government objectives are broad, and have been refined policy aims and objectives. These have been further distilled into a list of desired “outputs” and “outcomes” from a project that would meet the objectives.

These policy objectives will inform firstly the SMT and will then flow through to the subsequent evaluation processes (Options Assessment and Business Case).

The consolidated evaluation criteria developed and refined for the SMT in this project are shown in Table 3-2 below.

Table 3-2: Evaluation Framework for the SMT

<table>
<thead>
<tr>
<th>Strategic Merit Test (SMT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGHLY ACCESSIBLE OPTION</td>
</tr>
<tr>
<td>HIGHLY INTUITIVE OPTION</td>
</tr>
<tr>
<td>MAXIMISED NETWORK INTEGRATION</td>
</tr>
<tr>
<td>MINIMISED MODAL CONFLICTS ON CORRIDOR</td>
</tr>
<tr>
<td>POTENTIAL FOR FAST TRAVEL SPEED</td>
</tr>
<tr>
<td>SERVES CURRENT DEMAND</td>
</tr>
<tr>
<td>ABILITY TO STAGE &amp; ALLOW FUTURE EXTENSIONS</td>
</tr>
<tr>
<td>COMPLIMENTS THE EXISTING RAIL NETWORK</td>
</tr>
<tr>
<td>MAXIMISED POTENTIAL TO REPLACE BUS SERVICES</td>
</tr>
<tr>
<td>CONSTRUCTABILITY</td>
</tr>
<tr>
<td>OPERABILITY</td>
</tr>
<tr>
<td>PROVIDES OPPORTUNITIES FOR NEW TRANSIT-ORIENTED EMPLOYMENT</td>
</tr>
<tr>
<td>SERVES OFF PEAK AND COUNTER PEAK DEMAND</td>
</tr>
<tr>
<td>MINIMISED IMPACT ON HERITAGE AND SENSITIVE LAND USES I.E. RESIDENTIAL USES</td>
</tr>
<tr>
<td>MINIMISED IMPACT ON NATURAL AND OPEN SPACE AREAS</td>
</tr>
<tr>
<td>SERVES AREAS OF HIGH CAR USE</td>
</tr>
<tr>
<td>SERVES AREA OF HIGH BUS USE</td>
</tr>
<tr>
<td>PROVIDES OPPORTUNITIES FOR RENEWAL OF URBAN DOMAIN</td>
</tr>
<tr>
<td>PROVIDES OPPORTUNITIES FOR NEW TRANSIT-ORIENTED HOUSING</td>
</tr>
<tr>
<td>SERVES AREAS OF POOR PUBLIC TRANSPORT ACCESSIBILITY</td>
</tr>
<tr>
<td>PROVIDES ACCESS TO REGIONAL RECREATIONAL, SPORTING AND CULTURAL FACILITIES</td>
</tr>
<tr>
<td>SERVES AREAS OF SOCIAL DISADVANTAGE</td>
</tr>
</tbody>
</table>

Against each criterion, the route options were rated “high”, “medium” or “low.

To make the SMT evaluation as clear as possible, examples of what can be considered “high” and “low” performance related to each criterion is provided in Table 3-3.
### Table 3-3: Examples of High & Low Performance against Criteria

<table>
<thead>
<tr>
<th>Policy Aims</th>
<th>Criteria</th>
<th>Example of High Rating</th>
<th>Example of Low Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Customer Experience</strong></td>
<td>Highly accessible option</td>
<td>Street network and gradient enables good access for customers</td>
<td>Gradients make access to stops or platform location difficult</td>
</tr>
<tr>
<td></td>
<td>Highly intuitive option</td>
<td>Direct Corridors linking key nodes</td>
<td>Indirect links between key nodes</td>
</tr>
<tr>
<td></td>
<td>Maximised network integration</td>
<td>Links to existing transit nodes</td>
<td>Does not serve key transit nodes</td>
</tr>
<tr>
<td></td>
<td>Minimised modal conflicts on corridor</td>
<td>Exclusive right of way along majority of corridor with priority at intersections</td>
<td>Operating in mixed traffic</td>
</tr>
<tr>
<td></td>
<td>Potential for fast travel speed</td>
<td>High average speeds (&gt;25km/h) likely</td>
<td>Low average speeds likely (&lt;15km/h)</td>
</tr>
<tr>
<td><strong>Productivity</strong></td>
<td>Serves current demand</td>
<td>Serves high current travel demand (centres, major trip generators, residential uses)</td>
<td>Low patronage demand within 800 metres of alignment</td>
</tr>
<tr>
<td></td>
<td>Ability to stage &amp; allow future extensions</td>
<td>Ability to open in stages and add logical extensions (mid or end of route)</td>
<td>Hard to stage delivery, no logical extensions</td>
</tr>
<tr>
<td></td>
<td>Complements the existing rail network</td>
<td>New infrastructure fills gaps in the existing rail network</td>
<td>Duplicates a rail corridor with spare capacity or exacerbates existing heavy rail congestion</td>
</tr>
<tr>
<td></td>
<td>Maximised potential to replace bus services</td>
<td>Replaces bus services on significant part of routes</td>
<td>Doesn’t reduce bus numbers in the corridor</td>
</tr>
<tr>
<td></td>
<td>Constructability</td>
<td>Alignment relatively easy to construct (technical feasibility – not cost)</td>
<td>Potentially significant construction issues (impact on neighbours, technically difficult)</td>
</tr>
<tr>
<td></td>
<td>Operability</td>
<td>Alignment relatively easy to operate</td>
<td>Potentially significant operational issues</td>
</tr>
<tr>
<td></td>
<td>Provides opportunities for new transit-oriented employment</td>
<td>Opportunities for future employment TOD</td>
<td>Limited potential for future employment TOD</td>
</tr>
<tr>
<td></td>
<td>Serves off peak and counter peak demand</td>
<td>Serves high peak period demand (possibly in both directions) as well as counter peak and off-peak demand</td>
<td>Serves peak period demand (possibly one direction) with limited counter peak or off-peak demand</td>
</tr>
<tr>
<td><strong>Sustainability</strong></td>
<td>Minimised impact on heritage and sensitive land uses i.e. Residential uses</td>
<td>Alignment with minimal impact on residential &amp; heritage areas</td>
<td>Alignment through heritage or residential areas</td>
</tr>
<tr>
<td></td>
<td>Minimised impact on natural and open space areas</td>
<td>Minimal impact of public open space</td>
<td>Significant impact on open space</td>
</tr>
<tr>
<td></td>
<td>Serves areas of high car use</td>
<td>Serves area of high car ownership &amp; use</td>
<td>Low car ownership &amp; use</td>
</tr>
<tr>
<td></td>
<td>Serves areas of high bus use</td>
<td>Serving areas of existing strong bus patronage (enabling bus redeployment)</td>
<td>Duplicates existing high capacity corridors, without relieving existing transit networks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Opens new areas of demand or provides a new service offering</td>
<td>Only serves existing transit markets</td>
</tr>
<tr>
<td><strong>Liveability</strong></td>
<td>Provides opportunities for renewal of urban domain</td>
<td>Potential for urban renewal of public domain along the corridor</td>
<td>No ability to improve public spaces in close proximity to the corridor</td>
</tr>
<tr>
<td></td>
<td>Provides opportunities for new transit-oriented housing</td>
<td>Opportunities for future Transit Oriented Development (TOD)</td>
<td>Limited opportunities for future TOD</td>
</tr>
<tr>
<td></td>
<td>Serves areas of poor public transport accessibility</td>
<td>Improves accessibility to public transport</td>
<td>Does not improve accessibility to public transport</td>
</tr>
<tr>
<td></td>
<td>Provides access to regional recreational, sporting and cultural facilities</td>
<td>Serves regionally significant sporting, recreational &amp; cultural facilities</td>
<td>Provides limited access to regionally significant sporting, recreational &amp; cultural facilities</td>
</tr>
<tr>
<td></td>
<td>Serves areas of social disadvantage</td>
<td>Serves areas of social disadvantage</td>
<td>Does not serve areas of social disadvantage</td>
</tr>
</tbody>
</table>

While the nature of the SMT means that rating of each alignment will be subjective, the above table highlights the features that optimal and sub-optimal alignments may have. More specific examples of how the ratings are assigned for each route option are provided in Section 3.6.
3.5. Test Route Options

A workshop attended by the Booz & Company and AECOM project team was held on the afternoon of Thursday 24 November and completed on the morning of Friday 25 November, when the long list of route options was assessed against the SMT criteria.

Feedback was sought from the TfNSW client project team on the same day after each session to ensure that their input and comments were captured.

It is important to recognise that the SMT tested whole standalone options (e.g. the USyd options) or individual component sections to form various standalone options (e.g. the UNSW southern section options).

For the purposes of this SMT, Booz & Company and AECOM have not weighted the criteria to reflect the equal importance of the four policy aim areas.

3.6. Results of the SMT

Table 3-4 overleaf shows how each option performed against the defined criteria.
### Table 3-4: Detailed Results of the SMT

Green text = positive attribute; Red text = negative attribute

<table>
<thead>
<tr>
<th>Option Description</th>
<th>Customer experience</th>
<th>Productivity</th>
<th>Sustainability</th>
<th>Liveability</th>
<th>Recommended SMT Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. CBD CORRIDOR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| **A** Central to Circular Quay (George St) | • Centrally located within the CBD, providing good access to employment, retail and entertainment precincts.  
• Operating in the ‘main street’ of Sydney is highly legible and intuitive.  
• Integrates with heavy rail network at three locations.  
• Potential conflicts with high volumes of traffic and buses. | • Potential to replace north-south CBD bus services.  
• Minimal conflict with car park and property (driveway) access.  
• Minimal engineering challenges. | • Potential to significantly reduce traffic in CBD.  
• Potential visual impact on heritage buildings (Town Hall, QVB).  
• Potential noise/vibration impact on theatres and cinemas. | • Provides good access to civic and cultural facilities.  
• Significant potential for improvements to public domain and reduction in overall traffic and noise levels. | **PROCEED to Options Assessment stage.** |
| **B** Circular Quay to Barangaroo (Hickson Rd) | • Links key tourism precincts in Circular Quay, Walsh Bay, The Rocks, Barangaroo (and potentially Darling Harbour).  
• Substantially improves public transport access to Walsh Bay.  
• Likely long journey time from Circular Quay to Barangaroo resulting from indirect route and conflicts with traffic in The Rocks. | • Supports employment and tourism at Barangaroo and Walsh Bay.  
• Complements the existing public transport network by providing a new service that does not impact on or duplicate existing operations.  
• Operational impact from likely shared running with traffic through The Rocks. | • Serves areas that are difficult to access by public transport, potentially reducing car trips.  
• Potential visual impact on heritage buildings (The Rocks).  
• Potential noise/vibration impact on Walsh Bay theatres. | • Improves access to cultural facilities in Walsh Bay and Barangaroo.  
• Potential to provide access to major events at Barangaroo Headland Park. | **PROCEED to Options Assessment stage.** |
<table>
<thead>
<tr>
<th>Option Description</th>
<th>Customer experience</th>
<th>Productivity</th>
<th>Sustainability</th>
<th>Liveability</th>
<th>Recommended SMT Outcome</th>
</tr>
</thead>
</table>
| C Sussex St & Hickson Rd | ▪ Links key tourism precincts in Darling Harbour, Barangaroo (and potentially Circular Quay).  
▪ Topography and adjacent harbour limits potential catchment compared to George Street option.  
▪ Likely long journey time from Central to Barangaroo and Circular Quay resulting from indirect route and conflicts with traffic in Sussex Street. | ▪ Supports employment and tourism at Barangaroo.  
▪ Significant engineering challenges associated with cross-fall of street.  
▪ Likely impacts on car park and property (driveway) access.  
▪ Limited potential to replace bus services in other CBD streets.  
▪ Operational impact from likely shared running with traffic in Sussex Street. | ▪ Minimal impact on heritage buildings.  
▪ Few sensitive uses that could be affected by noise/vibration. | ▪ Does not enable significant improvements to public domain. | DOES NOT PROCEED to Options Assessment stage. |
<table>
<thead>
<tr>
<th>Option Description</th>
<th>Customer experience</th>
<th>Productivity</th>
<th>Sustainability</th>
<th>Liveability</th>
<th>Recommended SMT Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2. USYD CORRIDOR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D Broadway &amp; Parramatta Rd</td>
<td>Highly accessible and legible option linking Central Station to UTS, TAFE, Central Park, University of Sydney.</td>
<td>Complements existing rail network by addressing gap in network coverage with high demand.</td>
<td>Minimal impact on heritage, residential, or open space land uses.</td>
<td>Provides access to retail centre on Broadway.</td>
<td><strong>PROCEED to Options Assessment stage.</strong></td>
</tr>
<tr>
<td></td>
<td>• Potential conflicts with high traffic volumes on Broadway and Parramatta Road with limited ability to divert or reduce traffic.</td>
<td>• Potential to extend along Parramatta Road to Leichhardt and Five Dock.</td>
<td></td>
<td>• Potential for renewal of urban domain and streetscape along route.</td>
<td></td>
</tr>
<tr>
<td>E Broadway &amp; City Rd</td>
<td>Highly accessible and legible option linking Central to UTS, TAFE, Central Park, University of Sydney.</td>
<td>Potential to extend along City Road to Newtown and Marrickville.</td>
<td>Minimal impact on heritage, residential, or open space land uses.</td>
<td>Provides access to retail centre on Broadway.</td>
<td><strong>PROCEED to Options Assessment stage.</strong></td>
</tr>
<tr>
<td></td>
<td>• Potential conflicts with high traffic volumes on Broadway and City Road with limited ability to divert or reduce traffic.</td>
<td></td>
<td></td>
<td>• Potential for renewal of urban domain and streetscape along route.</td>
<td></td>
</tr>
<tr>
<td>F Cleveland St &amp; Lee St</td>
<td>Does not serve UTS and TAFE.</td>
<td>Route does not serve existing demand.</td>
<td>Minimal impact on heritage, residential, or open space land uses.</td>
<td>Improves public transport accessibility in Chippendale and Darlington.</td>
<td><strong>DOES NOT PROCEED to Options Assessment stage.</strong></td>
</tr>
<tr>
<td></td>
<td>• Potential conflicts with high traffic volumes on Cleveland Street and City Road with limited ability to divert or reduce traffic.</td>
<td>• Difficult to construct high quality, accessible stops in relatively narrow Cleveland Street.</td>
<td>• Limited potential to replace City Road bus services.</td>
<td>• Does not provide access to regionally significant community facilities.</td>
<td></td>
</tr>
<tr>
<td>Option Description</td>
<td>Customer experience</td>
<td>Productivity</td>
<td>Sustainability</td>
<td>Liveability</td>
<td>Recommended SMT Outcome</td>
</tr>
<tr>
<td>--------------------</td>
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<td>-------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>3a. UNSW CORRIDOR – Northern Section</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| G Waterloo, Zetland & Kensington | • Provides an alternative route to UNSW from Airport line.  
• Relatively wide streets allow potential for reliable operations.  
• Relatively indirect link to UNSW (longest travel distance of all options). | • Supports future employment at Green Square.  
• Potential to replace some bus services in Surry Hills, but higher demand Anzac Parade buses and CBD will remain.  
• Serves areas within the catchment of railway stations. | • Most of the catchment does not have high existing car or bus demand (within rail catchment). | • Potential to stimulate TOD housing and regeneration in Waterloo and Zetland.  
• Does not serve Moore Park precinct. | DOES NOT PROCEED to Options Assessment stage. |
| H Surry Hills, Zetland & Kensington | • Relatively indirect route to UNSW.  
• Streets are narrow and discontinuous, which is likely to result in slow travel times due to interaction with traffic and frequent turns. | • Potential to replace some bus services in Surry Hills, but a high volume of buses in Anzac Parade and CBD will remain.  
• Operational impact from likely shared running with traffic through Surry Hills. | • Serves an area with a relatively high level of car use.  
• Construction and operational impacts on sensitive residential and heritage areas in Surry Hills. | • Provides access to high density, diverse land uses in Surry Hills.  
• Potential to stimulate TOD housing and regeneration in Zetland.  
• Does not serve Moore Park. | DOES NOT PROCEED to Options Assessment stage. |
| I Surry Hills & Moore Park | • Direct and intuitive option for travel to Moore Park and UNSW. | • Potential to replace high demand bus services in Anzac Parade corridor without affecting Oxford St buses.  
• Operational impact from likely shared running with traffic through Surry Hills. | • Construction and operational impacts on sensitive residential and heritage areas in Surry Hills. | • Serves Moore Park precinct.  
• Limited potential for new TOD housing. | PROCEED to Options Assessment stage |
| J Surry Hills (Tunnel) & Moore Park | • Potential for significant journey time savings over existing bus and other light rail options.  
• Potential for direct underground connection with Central Station. | • Could serve a regional, rapid transport function through future network extensions to east and south east suburbs.  
• Reduction in travel time could stimulate additional employment in Randwick area. | • Underground alignment avoids operating conflicts within sensitive residential and heritage areas in Surry Hills.  
• Greatest potential for mode shift from car due to legibility and high travel speed. | • Serves Moore Park with potential for fast shuttle service on event days.  
• Limited potential for new TOD housing. | PROCEED to Options Assessment stage |
<table>
<thead>
<tr>
<th>Option Description</th>
<th>Customer experience</th>
<th>Productivity</th>
<th>Sustainability</th>
<th>Liveability</th>
<th>Recommended SMT Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>K Central, Darlinghurst &amp; Moore Park</td>
<td>• Indirect route from Central to UNSW via Oxford Street increases travel time and modal conflict with bus and car.</td>
<td>• Potential to extend route to Paddington and Bondi along Oxford Street.</td>
<td>• Serves high current bus demand.</td>
<td>• Serves Moore Park precinct.</td>
<td>PROCEED to Options Assessment stage</td>
</tr>
<tr>
<td></td>
<td>• Indirect route from Central to UNSW via Oxford Street increases travel time and modal conflict with bus and car.</td>
<td>• Potential to extend route to Paddington and Bondi along Oxford Street.</td>
<td>• Serves high current bus demand.</td>
<td>• Serves Moore Park precinct.</td>
<td>PROCEED to Options Assessment stage</td>
</tr>
<tr>
<td>L Town Hall, Darlinghurst &amp; Moore Park</td>
<td>• Direct and intuitive option linking to Town Hall and heart of Sydney CBD.</td>
<td>• Serves travel demand for CBD employment with potential to replace bus services in CBD.</td>
<td>• Serves high current bus demand.</td>
<td>• Serves Moore Park precinct.</td>
<td>PROCEED to Options Assessment stage</td>
</tr>
<tr>
<td></td>
<td>• Longer trip for most rail passengers accessing UNSW compared with interchange at Central.</td>
<td>• Serves travel demand for CBD employment with potential to replace bus services in CBD.</td>
<td>• Serves high current bus demand.</td>
<td>• Serves Moore Park precinct.</td>
<td>PROCEED to Options Assessment stage</td>
</tr>
</tbody>
</table>

3b. UNSW CORRIDOR – Southern Section

<p>| M Kensington &amp; Kingsford | • Direct and intuitive option for travel to UNSW.                                   | • Potential for route extensions to high demand areas of south Sydney (e.g. Maroubra). | • Minimal impact on residential areas or open space.                      | • Serves existing high density residential area in Kensington.               | PROCEED to Options Assessment stage |
|                        | • Does not serve main entrance of Randwick Racecourse, upper campus of UNSW or PoW Hospital. | • Potential to replace buses and provide bus interchange at Kingsford.         | • Potential for route extensions to high demand areas of south Sydney (e.g. Maroubra). | • Potential for renewal of urban domain and associated public realm improvements in Kingsford. | PROCEED to Options Assessment stage |
| N Kensington &amp; PoW Hospital | • Direct and intuitive option for travel to UNSW.                                   | • Potential to replace buses.                                                  | • Greatest coverage of university and hospital precinct provides greatest potential to reduce car use. | • Greatest coverage of university and hospital precinct provides greatest potential to reduce car use. | PROCEED to Options Assessment stage |</p>
<table>
<thead>
<tr>
<th>Option Description</th>
<th>Customer experience</th>
<th>Productivity</th>
<th>Sustainability</th>
<th>Liveability</th>
<th>Recommended SMT Outcome</th>
</tr>
</thead>
</table>
| Randwick & PoW Hospital | • Direct and intuitive option for travel to Randwick Racecourse, Randwick centre and PoW hospital.  
• Does not directly serve UNSW or NIDA.  
• Potential conflicts with bus, cars, pedestrians and parking through Randwick centre. | • Opportunity to serve existing and future employment in Randwick Centre.  
• Potential to replace buses and provide bus interchange at Randwick.  
• May not allow replacement of bus services to UNSW.  
• Some gradient challenges in Alison Road. | • Minimal impact on residential areas or open space. | • Serves existing high density residential and retail area in Randwick centre.  
• Provides best access to Centennial Park.  
• Potential for renewal of urban domain and associated public realm improvements in Randwick. | PROCEED to Options Assessment stage |
The following points emerge from the above table:

1. The CBD Corridor
   - The constructability issues on building the Barangaroo extension via from George Street and via Dawes Point (narrow width and steep gradient) makes the combined George Street and Barangaroo option potentially difficult;
   - The inability to replace bus routes and the high number of vehicular entry points on Sussex Street makes it a less desirable option;
   - The George Street option is centrally located, has Council support for significant urban design changes and would enable a significant reduction in buses entering the CBD; and
   - The combined George St and Barangaroo extension through The Rocks would serve a mainly tourist and local travel market.

2. The USyd Corridor
   - The option of Sydney University to Railway Square via Parramatta Road is relatively short and would not justify replacing whole bus routes in the corridor;
   - The City Road option provides the best access to existing campus activity but also duplicates coverage provided by Redfern Station;
   - An option which is extended to serve Royal Prince Alfred Hospital, either at the City Road end via Carillon Ave or at the Parramatta Road end via Missenden Road, would generally perform better because of the enhanced catchment; and
   - Parramatta Road is a route option which has the potential for light rail extensions beyond current proposals which would better enable the replacement of CBD bus services.

3a. The UNSW Corridor – Northern Section
   - The UNSW northern option via Green Square is not as attractive as other route options such as Anzac Parade or High Street (which have more trip attractors en route and at the destination);
   - Options to the far west of the corridor performed poorly in the SMT due to duplicating the existing connection provided by the Airport Rail Link, whilst not offering the opportunity to replace bus services to the CBD;
   - The options which deliver passengers into the Town Hall area are likely to be popular as there are more final destinations in the mid-CBD than in the Central station area. Also, there is a concentration of students residing in the city, e.g. in World Square, Goulburn Street, George Street and Kent Street.
     - However, constructability and operability considerations might diminish the option’s overall attractiveness.
     - Furthermore, the interchange to heavy rail at Town Hall station is already congested because of high loadings on trains approaching Town Hall station and the station itself has limited platform and vertical transportation capacity. Therefore, Central station is likely to provide an easier interchange for most passengers heading in the counter peak direction along Anzac Parade;
The option using a tunnel through Surry Hills could have constructability issues but will reduce journey times and has other strategic advantages in terms of minimising impacts on surrounding residents. The cost of the option is not a significant consideration for the SMT but will need to be considered carefully in subsequent assessment phases; and

The option using Oxford Street and then heading south into Central Station is less intuitive than others as it would get people close to the centre of the CBD (Town Hall) but need to turn south in the final few hundred metres. Any connection from this alignment to the CBD spine (northbound) would compound the travel time and legibility issues on such a route.

3b. The UNSW Corridor – Southern Section

- The Anzac Parade route to Kingsford is a direct alignment with high density development south of Dacey Avenue. This has significant bus numbers on the corridor and rates well in the SMT, despite only travelling past the western edge of UNSW;

- The Alison Road route to Randwick has less commercial activity but similar residential activity to Anzac Parade. It is a direct link that serves the front entrance to Royal Randwick Racecourse but also traverses a significant stretch of open space (Centennial Park);

- The High Street route (between Anzac Parade and Belmore Road) is direct and serves the whole of UNSW and the Prince of Wales Hospital; it would completely cover several hundred services every weekday on Routes 890, 891 and 892.

The SMT resulted in eleven options being shortlisted for the next phase of assessment. These are shown in Figure 3-1 below.
Figure 3-1: Shortlisted route options from the SMT

Legend
- CBD Corridor Routes
  A: Circular Quay to George St
  B: Circular Quay to Barangaroo (Hickson Rd)
- USYD Corridor Routes
  D: Broadway & Parramatta Rd
  E: Broadway & City Rd
- UNSW Corridor Routes
  H: Dover Heights
  I: Surry Hills & Moore Park
  J: Central, Darlington & Moore Park
  L: Town Hall, Darlinghurst & Moore Park
  M: Kensington & Kingsford
  N: Kensington & Prince of Wales Hospital
  O: Randwick & Prince of Wales Hospital
- Long list options discarded from shortlist
- Potential future extension

Source: Base data copyright LPMA 2011 with AECOM and Booz & Company analysis (2011)
3.7. Summary: Shortlist of Route Options

The following summarises the shortlist of route options that Booz & Company and AECOM are recommending for the Option Assessment stage of Phase 2 (i.e. testing the demand for each shortlisted option):

- **CBD Corridor:**
  - Option A: Central to Circular Quay George Street
  - Option B: Circular Quay to Barangaroo via Hickson Rd

- **University of Sydney Corridor:**
  - Option D: Central to RPAH via Parramatta Road/Broadway
  - Option E: Central to RPAH via City Road

- **University of NSW Corridor – Northern Section:**
  - Option I: Central to UNSW Via Surry Hills and Moore Park
  - Option J: Central to UNSW Via Surry Hills and Moore Park (tunnel)
  - Option K: Central to UNSW Via Darlinghurst and Moore Park
  - Option L: Town Hall to UNSW Via Darlinghurst and Moore Park

- **University of NSW Corridor – Southern Section:**
  - Option M: Via Kensington to Kingsford
  - Option N: Via Kensington to PoWH
  - Option O: Via Randwick to PoWH
4. Conclusions and Recommendations

4.1. Introduction

This chapter presents the conclusions arising from our analysis and the SMT and the recommendations drawn.

4.2. Conclusions

The Options Identification stage of the SLR Strategic Plan Phase 2 identified a total of 16 route options as part of a “long list” for the three corridors in the defined study area.

These route options were subject to a SMT which is intended to be a coarse sift of the options in order to arrive at a shortlist for demand testing and further development in the Options Assessment stage.

The options that have been shortlisted for further assessment through the SMT are shown in Table 4-1 below.

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Option</th>
<th>Route options to be tested in the SMT</th>
<th>Shortlisted</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBD</td>
<td>A</td>
<td>Central Station – Circular Quay via George St</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Circular Quay – Barangaroo via Hickson Road</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>Central Station – Barangaroo via Sussex St &amp; Hickson Rd</td>
<td>No</td>
</tr>
<tr>
<td>USyd</td>
<td>D</td>
<td>Central Station – RPA Hospital via Parramatta Rd</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>Central Station – RPA Hospital via City Rd</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>Central Station – RPA Hospital via Cleveland St &amp; Lee St</td>
<td>No</td>
</tr>
<tr>
<td>UNSW – Northern Section</td>
<td>G</td>
<td>Central Station – Todman Ave via Green Sq &amp; Elizabeth St</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>Central Station – Todman Ave via Surry Hills</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>Central Station – Dacey Ave via Moore Park &amp; Surry Hills</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>J</td>
<td>Central Station – Dacey Ave via Tunnel</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>Central Station – Dacey Ave via Oxford St</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>Town Hall Station – Dacey Ave via Anzac Pde</td>
<td>Yes</td>
</tr>
<tr>
<td>UNSW – Southern Section</td>
<td>M</td>
<td>Central Station – UNSW via Anzac Pde</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Central Station – PoW Hospital via High Street</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>Central Station – PoW Hospital via Alison Rd</td>
<td>Yes</td>
</tr>
</tbody>
</table>
4.3. **Recommendations**

On the basis of the findings of the SMT conducted, it is recommended that the following route options proceed to the Options Assessment Stage of the SLR Strategic Plan Phase 2 program:

- **CBD Corridor:**
  - Central to Circular Quay George Street
  - Circular Quay to Barangaroo via Hickson Rd
- **University of Sydney Corridor:**
  - Central to RPAH via Parramatta Road/Broadway
  - Central to RPAH via City Road
- **University of NSW Corridor – Northern Section:**
  - Central to UNSW Via Surry Hills and Moore Park
  - Central to UNSW Via Surry Hills and Moore Park (tunnel)
  - Central to UNSW Via Darlinghurst and Moore Park
  - Town Hall to UNSW Via Darlinghurst and Moore Park
- **University of NSW Corridor – Southern Section:**
  - Via Kensington to Kingsford
  - Via Kensington to PoWH
  - Via Randwick to PoWH

This stage of the analysis only examined the light rail modal option for particular strategic route options. Booz & Company and AECOM recommend that modal alternatives be considered for the shortlisted routes in the next stage of analysis to ensure a holistic perspective on mode selection for each route.
5. Bibliography

5.1. Bibliography

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