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Keep it Moving – Construction Phase Transport Planning

The growth of our major urban centres continues to accelerate. In turn this drives a need for new or enhanced transport infrastructure, particularly gateway capacity (airports and port terminal) and network capacity (mass transit and urban roadways). Whilst these projects have the ability to unlock bottlenecks and deliver lasting economic benefits – the key challenge is to construct this infrastructure in a sensitive urban environment whilst minimising impacts to existing transport users during construction.

This paper explores strategies to mitigate the impact of large infrastructure projects. Applying these strategies Mark has successfully demonstrated that it is possible to construct major urban infrastructure and 'keep the city moving'.

1 Introduction/ Overview

The growth of our major urban centres continues to accelerate. In turn this drives a need for new or enhanced transport infrastructure, particularly gateway capacity (airports and port terminal) and network capacity (mass transit and urban freeways). Whilst these projects have the ability to unlock bottlenecks and deliver lasting economic benefits – the key challenge is to construct this infrastructure in a sensitive urban environment whilst minimising impacts to existing transport users during construction.

2 Strategic Context

2.1 Background

Australia is undergoing a period of rapid population growth with the current population estimated at 24 million anticipated to grow to 30 million by 2031. A number of factors influence this growth, namely births, deaths and net migration. Amongst this our cities are growing at faster than our regional areas. In 2006, 88% of Australians lived in metropolitan urban areas compared with 58% in 1911[1]. This points to the ongoing economic success and growth of urban centres which attracts increasing number of people to employment opportunities and access to essential services such as health and education.

Increasing population fuels economic growth. However, there are costs to achieve this, one of which is congestion of existing infrastructure which in turns drives the need for new infrastructure. A recent report indicates that demand on many key urban road and rail corridors is projected to exceed current capacity by 2031. In 2011 the cost of delays on roads in the six largest capital cities was $13.7 billion.

[1] Population Growth and Distribution - http://www.environment.gov.au/science/soe/2011-report/2-drivers/3-population-growth

This is projected to grow to $53.3 billion by 2031[2]. There are a variety of strategies to address this issue including;

- Integrated land use and transport planning;
- Travel demand management measures; and
- Construction of new infrastructure.

This paper focuses on the third option which is the provision of new infrastructure to enhance capacity. Whilst the benefit of additional capacity is typically well received by the broader community, construction impacts and in particular, reduced or diminished network capacity to facilitate construction, is a point of frustration for community. This paper will explore strategies which seek to mitigate or eliminate these issues based on a series of case studies from which this author has contributed to professionally.

2.2 Major Transport Infrastructure Pipeline

Across all major Australian capital cities a range of major transport infrastructure projects are either under development or construction.

A selection of major infrastructure projects is presented below in Table 1 .

Table 1 Major Transport Projects Australia

Location	Project	Description
Melbourne, Victoria	Melbourne Metro	A 9-kilometre rail tunnel including 5 underground stations across Melbourne's CBD (estimated value $10.9 billion)
Melbourne, Victoria	CityLink Tulla Widening	Upgrade of a 24km freeway corridor from Melbourne Airport to Power Street
Melbourne, Victoria	Western Distributor.	Additional lanes on the West Gate Freeway, a proposed tunnel and elevated motorway that connects the West Gate Freeway with the Port of Melbourne, CityLink and the CBD, providing an alternate river crossing and easing pressure on the West Gate Bridge. Upgrades to the broader Monash Fwy corridor and improved access to Webb Dock
Sydney, NSW	Sydney Metro	A 30-kilometre rail line including a Sydney Harbour crossing and CBD rapid transit line.
Sydney, NSW	WestConnex	A 33 kilometre project that brings together a number of important road projects which together form a vital link in Sydney's Orbital Network. They include a widening of the M4 east of Parramatta, a duplication of the M5 East and new sections of motorway to provide a connection between the two key corridors.
Sydney, NSW	NorthConnex	NorthConnex is a 9km twin tunnel motorway linking the M2 and M1
Brisbane, QLD	Cross River Rail	Cross River Rail is a transformational 10.2km rail link connecting Dutton Park in the south to Bowen Hills in the north, with 5.9km of tunnel under the Brisbane River and CBD. It will deliver new services to stations at 5 key locations including Boggo Road, Woolloongabba, Albert Street, Roma Street and Exhibition showgrounds.
Adelaide, SA	Torrens to Torrens	a 4km non-stop roadway (incorporating 3 km lowered motorway), between Ashwin Parade, Torrensville, and Pym Street, Croydon Park, providing significant travel time saving to commuters and freight.

[2] Infrastructure Australia Audit - http://infrastructureaustralia.gov.au/policy-publications/publications/files/Australian-Infrastructure-Audit-Executive-Summary.pdf

Perth, WA	Gateway WA	Perth Airport and Freight Access Project which includes online widening of the Tonkin Highway to 6 lanes and upgrade of the Leach Highway to Expressway standard.

From the above list it is clear that there is a significant pipeline of transport projects in Australia. These projects are focused in major urban centres with significant interfaces to other elements of the existing transport system – this results in complex construction phase planning to manage/ mitigate impacts on the broader transport system.

2.3 Gateway Capacity versus Network Capacity

In developing this paper it is important to differentiate between gateway and network capacity based on the function and economic contribution of each element.

A gateway is key node which facilitates international or inter-state access to a place or region. Gateway capacity is essential to create connections with trade markets. Increasing gateway capacity provides certainty to import/ export orientated industries of the ability to move a product or service. This increased confidence can underpin macro-economic growth. Examples of gateway facilities are port terminals, airports and inter-modal terminals.

A network is a system of connected links which facilitate point to point travel. Major cities tend to have a strategic roadway network with local, arterial and freeway roads. In addition, many cities will have a public transport network. This can take the form of an on-road system, such as a bus or tram network, or a unique network, such as a metro railway network. Key points of high demand, for example the meeting point to two major roadways or the inner core of a rail network tend to be the formation point of congestion or bottlenecks. This leads to inefficiencies or delays locally and in the broader transport network. These issues can be alleviated by asset investment to increase capacity or supply. However, as a cautionary note the release of new capacity is often rapidly consumed by demand, unless controlled by a price point.

3 Keep it Moving – Construction Phase Transport Planning

3.1 Overview

The design and construction of major transportation systems, such as, airports, ports and metro rail requires meticulous planning and execution to deliver 'fit for purpose' transport infrastructure that delivers lasting benefits to the community. Transport hubs seek to connect large volumes of passengers and freight with seamless connections to forward services. A key success of these hubs is the efficient movement of people and goods through the entire transport system.

Construction phase transport planning is critical to ensure successful delivery of major infrastructure projects. This is even more important as we seek to retrofit and upgrade our cities and existing infrastructure.

Construction in urban brownfield sites, such as existing airports or core business areas for urban rail, can pose a significant challenge to maintain access and transport services for existing users while accommodating construction traffic. This issue can be compounded by the need to close vital transport links, such as roads, for construction resulting in diminished network capacity at a time of peak demand.

3.2 What is important?

Metro rail is a prime example of complex brownfield development, often requiring the closure of core CBD streets to construct stations and adjoining commercial zones. This can lead to impacts on existing users (access to buildings and services) and surface level transport provision (public transport, general traffic, pedestrian and cyclists). In addition, the ability to service the construction site with labour, materials and supplies requires construction traffic to navigate congested urban streets.

These projects need to strike a balance between a solution that provides sufficient access for the construction team while maintaining a suitable provision for community that is both socially and politically acceptable. The consideration and development of a construction phase transport plan is key to the success of these projects. The development of the plan is also an essential measure to identify and mitigate project risks and provide confidence to the project team of successful completion of the project.

3.3 Why is it important?

The primary goal of construction transport planning in a brownfield setting is to minimise the impact of construction on existing transport users and maintain safe access and mobility for community. Undertaking construction in a confined environment, such as a city centre, it is imperative to ensure reliability in the supply of materials to site and minimise the dwell time of materials at the site. That is, in an ideal world materials would be delivered to site when they are needed thus reducing the need to stockpile or store products on-site. Typically this is driven by the constraint of available space at the primary construction site – thus driving innovation in the supply chain.

In a congested urban environment, this can pose an issue as delay associated with congestion can create variability in travel time to site. Delayed receipt of inputs can impact on overall construction efficiency. Similarly a surge of construction vehicles on the local network can lead to congestion and delay for all road users.

To mitigate against such events it is commonplace to secure a staging area in proximity to the construction site. This is an area where materials can be received and stored in preparation for a short trip to site when required. This approach has many advantages. Firstly, the receipt of materials in advance gives certainty to the construction team ahead of installation.

Conversely any delays in receipt can be communicated to the construction team to plan and adjust activities accordingly. Secondly, locating the staging area in proximity to the construction site ensures consistent travel times of the materials to the construction zone maintaining the overall efficiency of the construction site. Similarly minimising delay for existing transport users is of an equal importance.

Increasingly technology is playing a greater role in tracking and monitoring the transport and supply of products to site. This can provide useful feedback such as optimal route selection to avoid congestion and identify non-peak time period which facilitate reduced travel times. Also, existing transport operations near the site can be monitored to ensure the works do not impact on the wider transport network.

3.4 How to do it

Successful planning requires a user centric focus, which seeks to minimise the impact of works and delays on existing users while facilitating efficient construction. This needs to be fully understood and embedded into the framework of the construction phase transport plan.

For example, it may be a requirement to maintain a public transport route or a compliant access pathway around a site for pedestrians, which means it may be an objective to minimise delay for these users. Identifying these requirements and objectives provides the project team with a clear framework to consider solutions.

For a metro rail design an integrated approach is imperative, working seamlessly with range of technical professionals such as construction experts and station designers to identify optimal staging arrangements for stations.

The focus of this task is to minimise the number of construction stages or changes to surface level transport in while providing sufficient space and access for station construction. Multiple stages result in delay and inefficiency of construction as time and effort is lost to adjust the site boundary and set up traffic management. From a user perspective, multiple stages can lead to frustration due to the additional time impact to construction and the difficulty in wayfinding around a constantly changing site. The benefits of this integrated approach are the ability to maintain existing surface transport while improving the overall efficiency of construction, producing a win for all stakeholders.

The solutions above are just some of a suite of measures which can be applied to ensure effective construction phase transport management. Further strategic tools and measures are outlined in Appendix A with individual case studies outlined in the following sections.

4 Case Studies

4.1 Port Capacity Project

4.1.1 Overview

The Port of Melbourne Corporation (PoMC) is undertaking the Port Capacity Project to increase gateway capacity at the Port of Melbourne in order to meet the projected increase in container trade. As part of this project, Webb Dock is being redeveloped to include an international container handling facility.

Aurecon were engaged by PoMC to provide transport planning advice in relation to the project. This covered a number of engagements including an assessment of the proposed road network, advice on travel demand measures and the development of a planning tool which forecasts future traffic movements to assist in proactively managing traffic during construction.

4.1.2 The Challenge

To deliver the necessary maritime and land infrastructure required intensive construction activity at Webb Dock, in addition to existing port activities. There was also construction activities related to the development of individual sites such as the new international container terminal. All this activity occurred during a time period when the capacity of the port road network was varying due to the construction of new infrastructure.

4.1.3 Mitigation Measures

Construction Phase Planning and Monitoring Tool

To effectively manage road operations it was desirable to develop a tool to project future traffic volumes to identify peaks in activity during the construction phase of the project. The benefit of identifying these scenarios in advance was the ability to influence or adjust road user behaviour and or available road space.

The task was to develop an Excel-based forecast tool which utilised a combination of historic and predicted traffic data to produce future traffic forecasts during the construction phase of the Port Capacity Project. The tool was able to consider individual port operations and construction activities with the aim of producing traffic volume forecasts for each road link and tuning movements at key intersections.

The first process was the development of the road network on a visual background. To maximise the benefit of the tool all known existing and future road links and site access points were included. Figure 1 is an indicative representation of the road network layout.

Figure 1 Indicative Road Network Layout

A key benefit of this tool is the ability to code the availability of road links. For example, Figure 1 shows the future road network links as dashed to reflect that these roadways were at the time of development not construction (i.e. available). This availability conditions allows for the opening and closure of road links to reflect changing traffic management throughout the construction period.

The next process in the development phase was the input of demands or traffic generation. During the construction period the following activities were likely to generate traffic from the precinct:

- Existing port operations
- Future port operations (i.e. international container park, empty container park etc.)
- Landside construction traffic
- Maritime construction traffic.

It should be noted that external traffic on the public road network was also included.

The key benefit of this tool was the ability to project forward and identify times of increased travel demand within the precinct. This provided the operator and constructor an opportunity to re-plan activity or adopt alternative methods, outlined below, to reduce congestion at the site.

4.1.4 Travel Demand Management

A series of demand management strategies are presented below. It should be noted that only some of these have been adopted for the Port Capacity Project. Some others have been adopted for another large gateway capacity enhancement project – Dublin Airport Terminal 2. However, for the purposes of this paper these are considered relevant given the common aspects of a gateway infrastructure project.

- High productivity freight vehicles – to carry more on less vehicles
- Use of off-peak and overnight network capacity – to minimise journey times (and delay) and increase fleet utilisation.
- Off-site staff parking with a shuttle bus service – to minimise the number of car trips to the construction site.
- Off-site staging yard – to consolidate construction materials before the ‘last mile’ trip to the construction site.

The ability to project future travel demand allied to the opportunity to reduce this demand through a series of strategic levers was imperative to maintaining a fully functional port whilst major construction activities advanced concurrently

4.2 William Street Watermain Renewal

4.2.1 Overview

Aurecon were engaged by City West Water to provide technical advice and prepare a Traffic Management Plan (TMP) for the William Street Water Main Renewals Project. The project involved the closure of the northbound carriageway of William Street in Melbourne's core central business district to support the construction activities relating to the renewal of water mains along the street. Construction was undertaken using a staged open trench technique. This required the progressive closing and opening of sections of the northbound carriageway.

4.2.2 The Challenge

William Street is a key transport corridor through the city supporting tram route No. 55 and north-south road based traffic. In determining the construction methodology it was imperative to strike a balance between the functionality of the transport network, the needs of stakeholders and an efficient and safe construction method.

Night time works were not considered suitable due to impact on responding residents/ businesses and health and safety concerns. This resulted in day works lasting 3-4 weeks for each section. The total construction timeline for all sections was approximately 6 months.

Closing the northbound lanes of a major roadway through the city centre was a significant concern for all stakeholders. Through the stakeholder engagement phase a series of mitigation measures were developed and considered.

4.2.3 Mitigation Measures

In developing the TMP, a number of mitigation measures have been considered. The overarching aim of these measures is to minimise the impact of the proposed works on the surrounding transport network.

These measures were developed with input from a number of sources, such as consultation with key stakeholders, modelling results, site visits and appreciation of traffic operations. The sections below outline the adopted mitigation measures.

Construction Phasing

The initial construction phasing was to commence construction at the southernmost section of William Street, between Flinders Street and Collins Street. However, citywide microsimulation modelling undertaken for the project identified that the transport impacts of the works are greatest in the southern sections, particularly along William Street between Flinders Street and Collins Street, and William Street between Collins Street and Bourke Street.

Based on this information and in the interest of improved traffic operations, the construction sequencing was adjusted to commence to the north of Bourke Street and continue to the northern extent before returning to the southern segments.

The key rationale of this approach was that working in these segments with limited transport impacts, will provide a vital feedback loop to the project team. Monitoring the traffic operations and mitigation measures provided an opportunity to refine and improve these measures before commencing in critical segments. Ultimately, construction in the northern segment was successful with manageable transport impacts. This allowed the contractor, and stakeholders, to progress to the critical segments with confidence in the proposed methodology and mitigation measures.

Subphase – Flinders Street – Collins Street

Further to the construction phasing approach which is outlined above, traffic modelling identified significant impacts with closing William Street to northbound traffic from Flinders Street to Collins Street. To mitigate this impact the following was implemented:

- Split the segment into two sub-phases:
  - Flinders Street to Flinders Lane; and
  - Flinders Lane to Collins Street.
- Maintain a single northbound lane in each section during weekday morning peak periods.

A comparison of modelled northbound vehicle throughput for the various scenarios is presented in Figure 2. It should be noted that a key assumption, agreed with stakeholders, was that 25% of existing traffic would either divert from the corridor to an alternative northbound route.

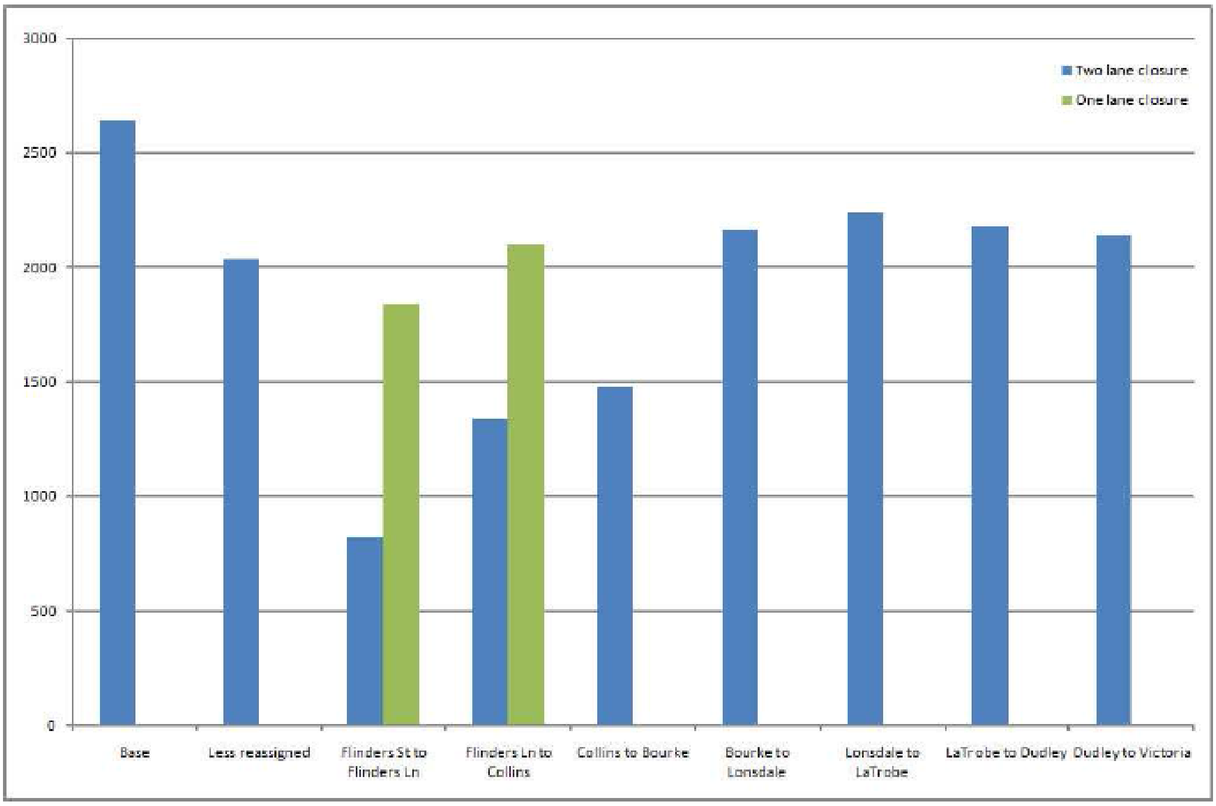

Figure 2 Comparison of Modelled Vehicular Throughput

The figure above highlights that through most of the construction phases a similar level of throughput was maintained when compared to the reassigned base case.

Tram Measures

A series of measures were adopted to support tram operations. This included a tram extension phase for northbound tram operations on Williams Street at traffic signal controlled intersections. In addition, flexi bollards were positioned on Queensbridge Street and flagmen were proposed at key city intersections to prevent vehicles impeding tram movements.

Intersection Layouts

Interventions to improve traffic flow at the intersection immediately to the south of a closed segment of William Street were developed.

The staging of the construction works required the closure of one major city block (i.e. Bourke St – Lonsdale St) to northbound traffic at a time. This resulted in the through lane immediately south of the closure being redundant whilst the works were active. Consequently only left and right turn movements were active to the south of the work zone. Normal operations, with a hook turn manoeuvre, results in both left turning and right turning vehicles utilising the nearside lane. Given that the left turn generally runs against a pedestrian phase, and the presence of three to four hook turning vehicles obstructing left turners, capacity is considered relatively low. The removal of the through movement creates an opportunity to separate the left turning and right turning vehicles, and therefore improve overall capacity for these movements.

Following consultation with stakeholders, the implementation of a fully controlled right turn for northbound traffic, immediately to the south of the road closure, was agreed. This resulted in left turning traffic utilising the left lane and right turning traffic utilising the right lane (or redundant through lane). To facilitate a fully controlled right turn it is necessary to alter the control and phasing of the intersection.

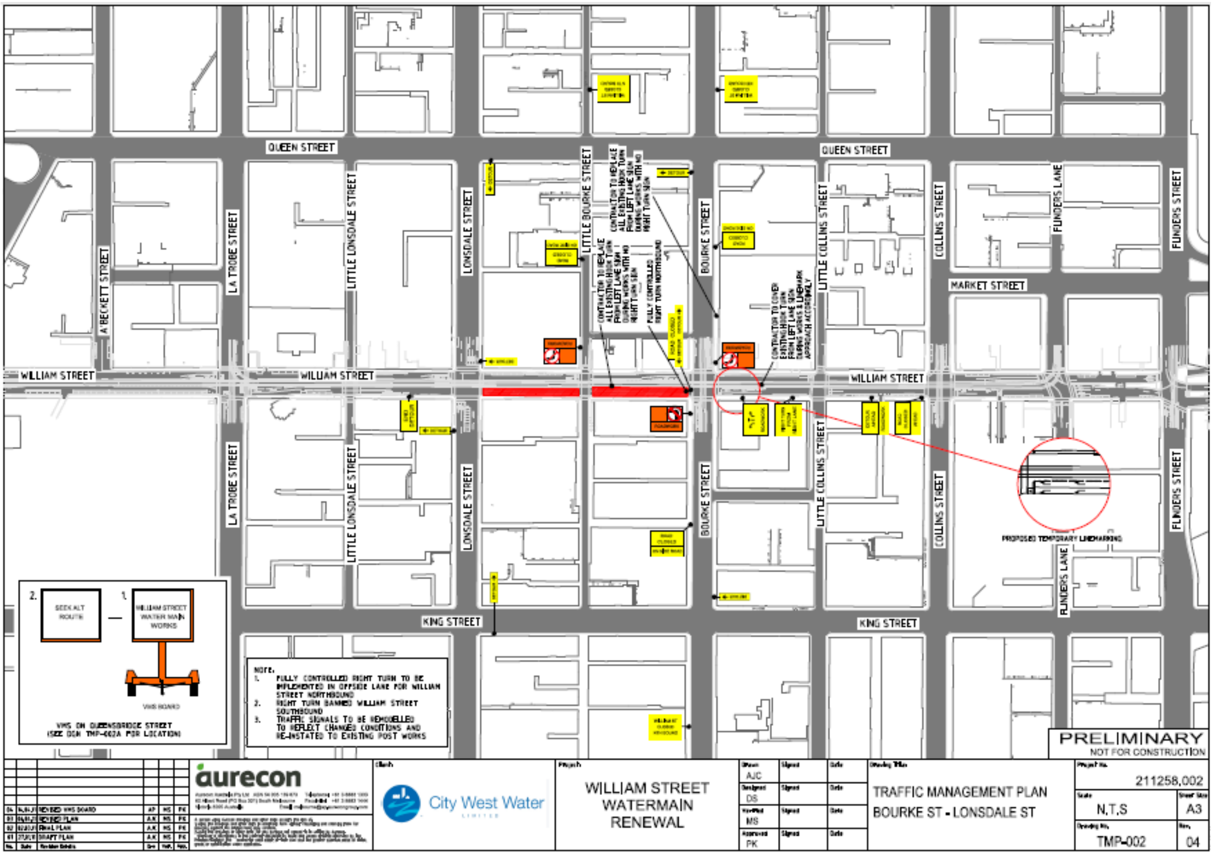

Figure 3 **Bourke Street to Lonsdale Street Closure TMP including Intersection Improvements**

Alternative Corridors

William St is a key north-south corridor through the CBD. Therefore, the closure of northbound sections of William St during the project required some users to utilise alternative northbound corridors. Three alternative northbound corridors were identified:

- Queen Street/ Franklin Street
- Clarendon Street/ Spencer Street
- Kings Way/ King Street

To promote the use of these alternative corridors, variable message signs (VMS) were positioned are strategic locations on the approach to the city. These signs were positioned at strategic decision points to notify motorists of the closure ahead whilst providing every opportunity to re-route.

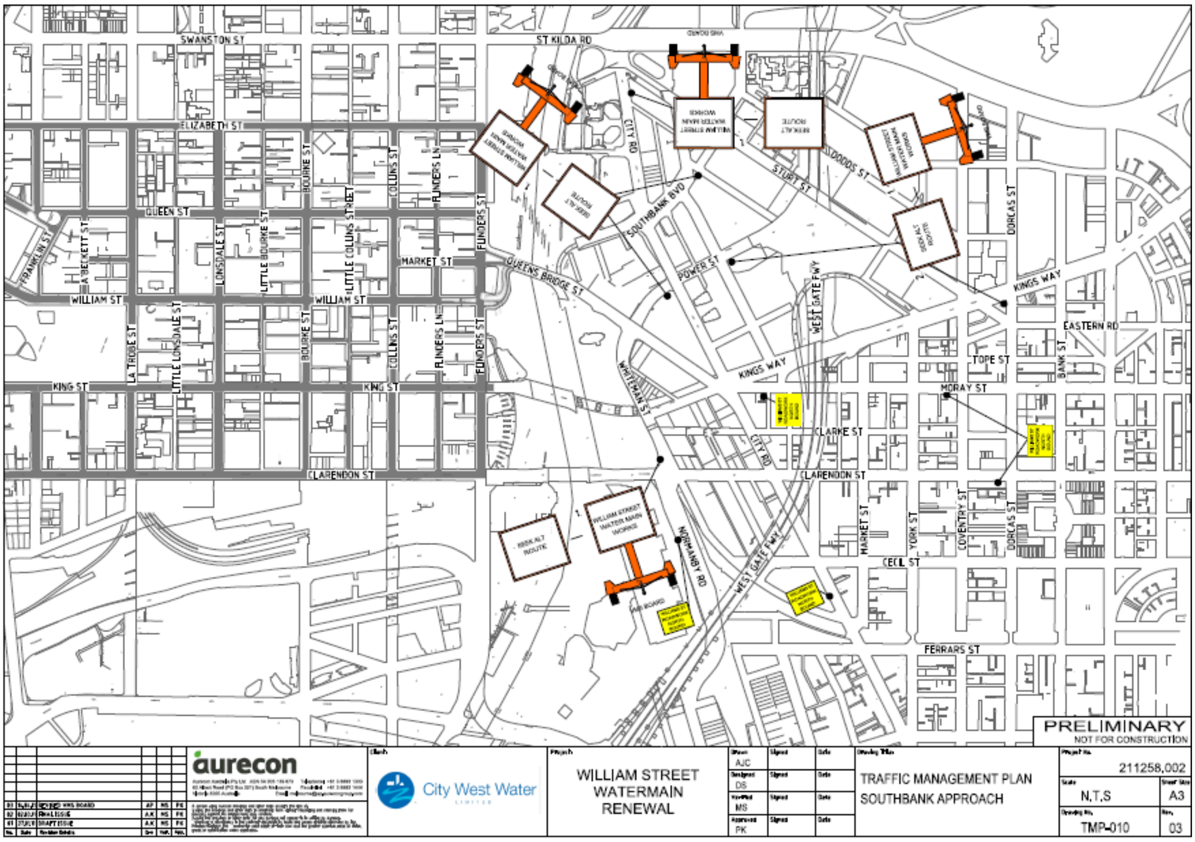

Figure 4 **Signage at Strategic Decision Points**

5 Conclusion

As our cities grow and evolve the upgrade of existing and provision of new infrastructure requires construction in complex urban environments. Whilst the legacy of improved infrastructure is well received by the broader community – the short term impacts of construction on transport networks can be a point of angst for community and political institutions.

Australia's major capital cities are experiencing population growth, this in turn leads to a greater demand for infrastructure. Existing transport systems are already suffering from the effects of congestion and delay – both of which will increase in the future. To address this there is significant infrastructure pipeline.

Construction phase transport plans consider the potential transport impacts of construction and identify solutions to achieve successful project delivery. Utilising real project experience a series of measures are presented in this paper which have been employed to deliver major urban projects. These include:

- Innovative modelling techniques – to test and respond to construction scenarios
- The staging and timing of the works - to minimise impacts on the transport systems.
- Measures to reduce trip generation at the construction site, such as remote car parking with a shuttle bus service and staging areas (travel demand management).
- Infrastructure capacity improvements – both locally and in alternative transport corridors.

Using these measures and others it is possible to construct large infrastructure and keep the city moving.

Appendix A - Strategic Toolbox

The following sections outline the strategic tools which can be utilised to mitigate the impact of construction.

Planning and Coordination

Early engagement with key stakeholders is critical to the success of any major project. Ideally, a Project User Group (PUG) should be formed. This should include key government agencies, such as municipal councils and transport agencies, as well as key local stakeholders, which may include local resident groups or the local chamber of commerce.

The purpose of a PUG is to allow formal communication between stakeholders and the design team. The PUG reviews and provides input into the project to ensure the design is acceptable and provides maximum benefit to users. The PUG allows all parties to plan and co-ordinate a major construction event.

Communications and Media

For a major project a Communications Plan should be developed to identify tools to communicate with the local community about impacts and key timeframes. The provision of accurate information on proposed works including any closures or changes to staging is a critical requirement for successful execution of a project. A range of tools and media (i.e. letter drops, community drop in sessions, twitter etc.) can be used to contact the public providing an overview of the proposed works and allowing feedback to inform mitigations measures or indeed changes to the design.

Travel Demand Management

Travel Demand Management (TDM) (also known as Mobility Management) is a general term for various strategies that increase transportation system efficiency. TDM treats mobility as a means to an end, rather than an end in itself. It emphasises the movement of people and goods, rather than motor vehicles, and so gives priority to more efficient modes (such as walking, cycling and public transport) particularly under congested conditions. Typically, it priorities travel based on the value and costs of each trip, giving higher value trips and lower cost modes priority over lower value, higher cost travel, when doing so increases overall systems efficiency.[3]

Whilst a relatively new concept in Australia, TDM is commonly used in Europe. The historic nature of cities in Europe, often characterised by narrow winding streets, means that the opportunity to increase network capacity, say by widening a road, is not as feasible there as Australia. This requires decision makers to utilise policy levers, often to re-allocate roadway space to more efficient modes of transport in line with sustainability policy initiatives.

Measures to reallocate road space are only one facet of TDM. Others include measures to vary the price or cost of a trip, say by levying car parking to supress or reduce car based demand, or to subsidise or reduce the cost of public transport to promote it.

Infrastructure

The ability to enhance or optimise the capacity of local infrastructure to support a major construction site is highly desirable. This varies in size and scale depending on the extent of construction. For example, for a major urban construction site which requires lane closures on a key arterial road or motorway, it may be necessary to boost or enhance capacity on an alternative corridor. This enhancement can take several forms, from simple measures, such as changing parking lanes to clearways and remodelling traffic signals to boost green time for key movements, through to more

[3] TDM http://www.vtpi.org/tdm/tdm51.htm

complex measures, such as localised widening to create additional capacity. Whilst these measures are temporary in nature to support construction there may be an opportunity to retain certain improvements as a lasting legacy.

Operational Plans

An Operational Plan is a tool to detail how each function will operate at a given time. For example in a constrained urban roadway corridor, construction traffic may be limited during peak periods to allow general traffic to traverse the corridor with minimal delay. Conversely during the inter-peak and post evening peak period, general traffic capacity may be reduced by say closing a traffic lane and allocating this space to construction loading. Operational Plans seek to strike a balance between the complex and competing needs of all stakeholders.