Sydney Science Park
Luddenham
Planning Proposal
Transport and Traffic Assessment

transportation planning, design and delivery

1359028000 17/12/13

GTAconsultants

Sydney Science Park

Luddenham

Planning Proposal

Transport and Traffic Assessment

Issue: B 17/12/13

Client: APP Corporation Pty Limited
Reference: 13S9028000
GTA Consultants Office: NSW

Quality Record

Issue	Date	Description	Prepared By	Checked By	Approved By	Signed
A	16/12/13	Final	R Manahan	J Rudd	J Rudd	Jason Rudd
B	17/12/13	Final - Revised Figures	R Manahan	J Rudd	J Rudd	

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1. Introduction

1.1 Background

A Planning Proposal is being submitted to Penrith City Council (Council), on behalf of E.J. Cooper & Son Pty Limited (EJC), in support of an amendment to the Penrith Local Environmental Plan (LEP) 2010.

The proposal is to rezone a 288 hectare parcel of land at 565-609 Luddenham Road, Luddenham to accommodate a new integrated mixed use research and development, employment, education, retail and residential specialised centre. The Planning Proposal is supported by a Master Plan, which represents the overall planning framework and preferred outcome for Sydney Science Park.

GTA Consultants (GTA) has been commissioned by APP Corporation Pty Ltd (APP) on behalf of EJC to undertake a transport assessment to accompany the Planning Proposal.

1.2 Sydney Science Park

The Planning Proposal site is located within the Broader Western Sydney Employment Area (BWSEA). The State Government's vision for the BWSEA is:

"to provide well located, serviced employment lands to secure the State's future productivity and economic growth. The BWSEA is an appropriate location to address employment in Western Sydney".[1]

The proposed development concept, referred to as the Sydney Science Park Project, presents a unique vision for development in Western Sydney which is consistent with the vision for the BWSEA.

The Sydney Science Park Project seeks to integrate research and development, employment, education and residential uses within the one site and designed around the three important principles of food security, energy and health.

The Sydney Science Park Project will incorporate an integrated residential precinct promoting living close to employment activities which responds to the lifestyles of scientific professionals and students.

The Sydney Science Park would be supported within the site by related land uses such as a local retail centre, various densities of residential accommodation including student housing, and recreational facilities.

The Sydney Science Park Master Plan includes:

- approximately 340,000 square metres of research and development floor space
- approximately 100,000 square metres of education floor space
- a Town Centre including a 30,000 square metre mix of retail floor space and residential apartments
- 3,400 dwellings including student housing
- a primary school
- new roads and infrastructure
- sporting fields and parks.

[1] Broader Western Sydney Employment Area, Draft Structure Plan (June 2013).

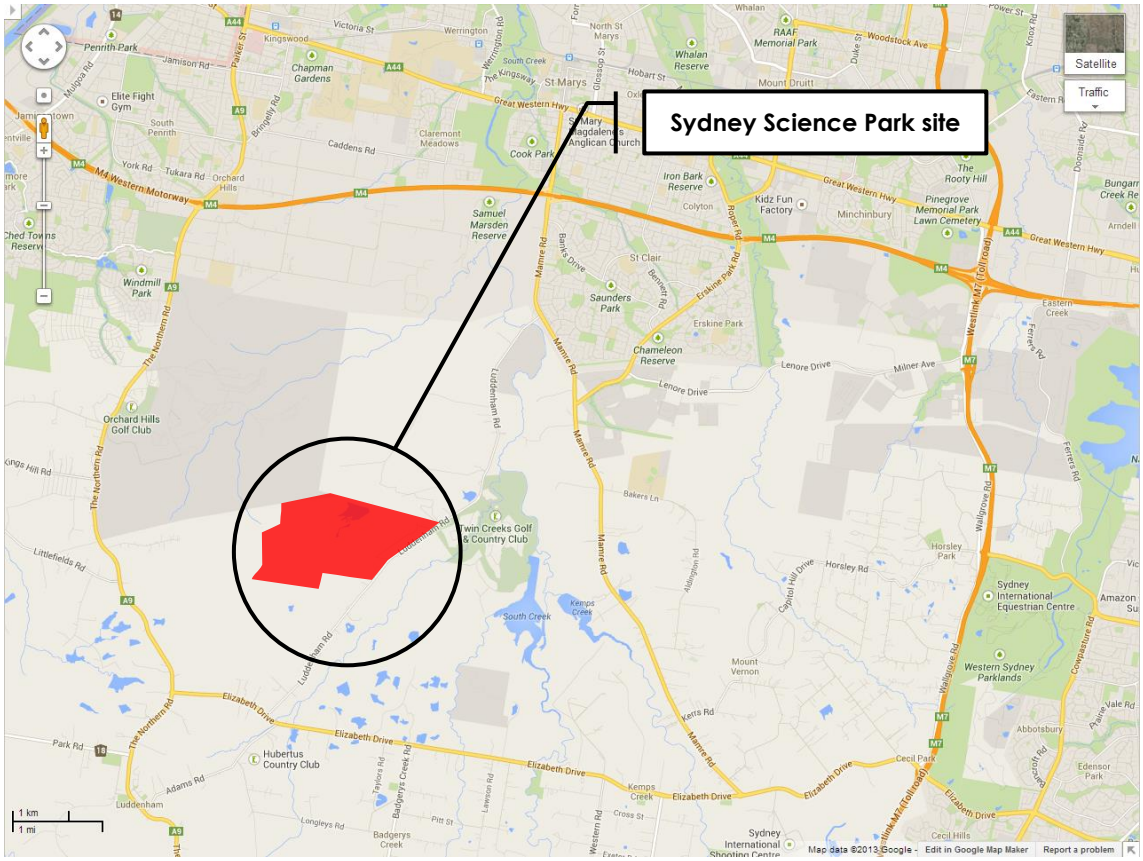
It is considered that the Sydney Science Park Project incorporates and enhances the vision for securing long term employment with the BWSEA.

1.3 Location

The Sydney Science Park site is located to the west of Luddenham Road in Luddenham. The site has a frontage of approximately 1.5 kilometres along Luddenham Road, with the northernmost part approximately 1.4 kilometres from where Luddenham Road crosses over the Sydney Water pipeline running between Warragamba Dam and the Prospect Reservoir.

The site location is shown in Figure 1.1.

Figure 1.1: Site Location



Basemap Source: Google Maps

1.4 Purpose of this Report

The Sydney Science Park Project will, once fully developed, contribute towards increased activity on the site, compared with the activity envisaged for the site in the BWSEA Structure Plan.

This report sets out an assessment of the anticipated traffic and transport implications of the Planning Proposal both within the context of the existing conditions surrounding the site and the future planned development of the BWSEA.

The transport assessment undertaken and presented herein has identified what transport infrastructure improvements are required to accommodate the Sydney Science Park Planning

Proposal both in the short and long term beyond those improvements already identified to occur as part of the BWSEA Structure Plan.

The assessment presented in this report includes consideration of the following:

i suitability of the site access arrangements in terms of supply (quantum), location and layout
ii staging of Sydney Science Park development within the context of the BWSEA
iii public transport access requirements
iv the traffic generating characteristics of the proposed developments within the site
v the likely future developments in the surrounding areas
vi the likely future transport infrastructure that would serve the area
vii traffic, transport and access impacts of the Planning Proposal on the surrounding transport network.

1.5 References

In preparing this report, reference has been made to the following:

- an inspection of the site and its surrounds
- *Broader Western Sydney Employment Area – Draft Structure Plan* (NSW Department of Planning and Infrastructure, June 2013)
- *Broader Western Sydney Employment Area – Economic Issues and Drivers Study* (Urbis, April 2013)
- *Broader Western Sydney Employment Area - Structure Plan: Transport Planning – Preliminary Analysis Report, Exhibition Draft* (GHD, June 2013)
- *Sydney Science Park – Traffic Modelling Report, (*GHD, December 2013*)*
- traffic and car parking surveys undertaken by SkyHigh, as referenced in the context of this report
- various plans for the proposed development prepared by DesignIQ for APP and EJC
- other documents and data as referenced in this report.

2. Regional Context

2.1 Strategic Policy and Planning Context

2.1.1 NSW 2021

In 2011, the NSW Government published *NSW 2021 – A Plan to Make NSW Number One*, comprising the foremost and the most recent overarching policy document that guides planning in NSW, in particular Metropolitan Sydney. The 10-year plan outlines steps to rebuild the economy, provide quality services, renovate infrastructure, restore Government accountability and strengthen our local environment and communities.

Based around the five strategies are 32 goals, with four focused on returning quality services within the transport sector:

- Goal 7: Reduce travel times
- Goal 8: Grow patronage on public transport by making it a more attractive choice
- Goal 9: Improve customer experience with transport services
- Goal 10: Improve road safety.

Transport agencies are investing in new and improved infrastructure to ensure that State Plan priority targets will be met. Investment in public transport infrastructure and programs are increasing the reliability and efficiency of the system. These and other initiatives will increase capacity in all forms of transport and make public transport a more attractive alternative.

2.1.2 Metropolitan Strategy for Sydney to 2031

The *Draft Metropolitan Strategy for Sydney to 2031* (NSW Government, March 2013) outlines the vision for the development of Metropolitan Sydney for the next two decades. It provides spatial guidelines on future housing and employment development to create and support new investment, and defines the required infrastructure investment to achieve balanced growth to 2031.

The transport infrastructure investments are integrated with the plans embodied in the *NSW Long Term Transport Master Plan* (NSW Government, December 2012). The *Metropolitan Strategy* also identifies the Western Sydney Employment Area as the "*single largest employment space in the Sydney Metropolitan Area once it is available to market.*"

Among the priorities the *Metropolitan Strategy* identifies for the Western Sydney Employment area are:

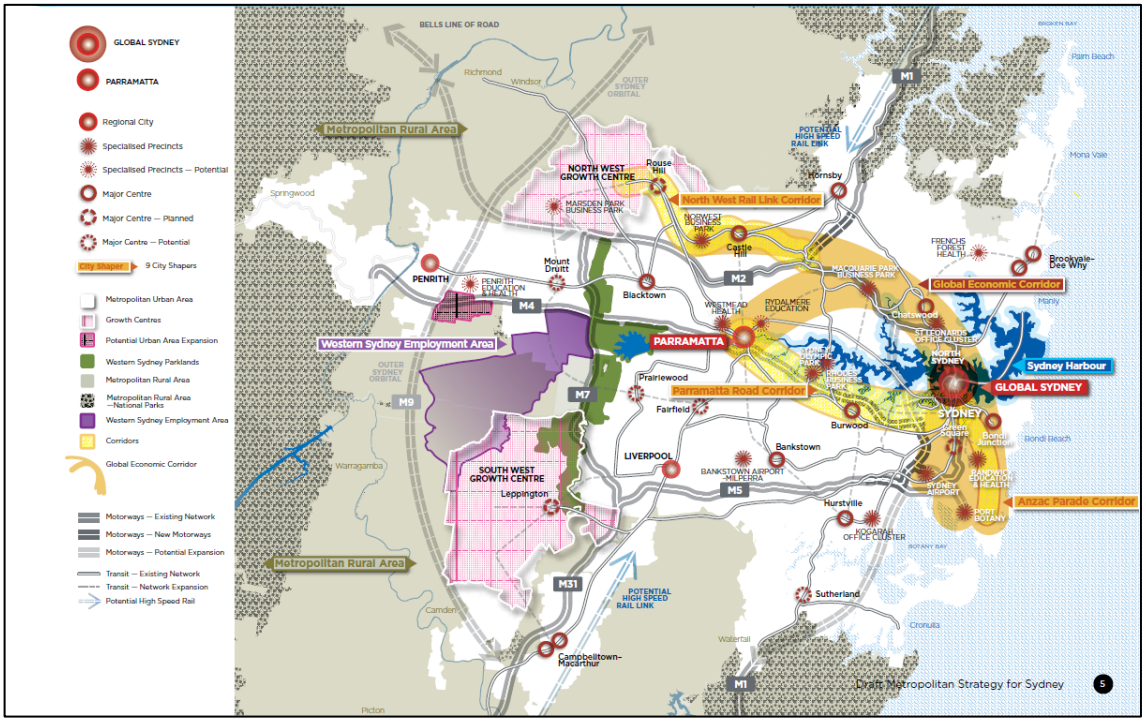
- investigate a potential south west expansion of the Western Sydney Employment Area of up to 10,000 hectares through a structure planning process
- encourage critical industries that support our economy's global functioning and promote employment, such as industrial uses, freight, logistics and research and development functions, as well as opportunities for agribusiness and food production
- identify opportunities to improve transport connections to the area, including protecting a corridor for the Western Sydney Freight Line and completing the Western Sydney Employment Area arterial network
- identify and protect opportunities for a major intermodal terminal at Eastern Creek

- investigate opportunities for better connections with surrounding centres such as possible transport connections to Mount Druitt, Fairfield and Leppington.

The Sydney Science Park site is located towards the western edge of the Broader Western Sydney Employment Area. The Sydney Science Park Planning Proposal also presents a significant opportunity to contribute to a number of the priorities for the Western Sydney Employment Area as identified in the *Metropolitan Strategy*, in particular the promotion of employment in research and development functions as well as opportunities for agribusiness and food production.

Figure 2.1 diagrammatically presents the vision for Sydney in 2031, as identified in the *Metropolitan Strategy*.

Figure 2.1: Vision for Sydney in 2031



Source: *Draft Metropolitan Strategy for Sydney to 2031* (NSW Government, March 2013).

2.1.3 NSW Long Term Transport Master Plan

The *NSW Long Term Transport Master Plan* (NSW Government, December 2012) sets out a framework for addressing the state's transport challenges for the next 20 years. The Master Plan serves as the "*guiding transport planning and policy document to support the goals in NSW 2021*". The NSW Long Term Transport Master Plan (LTTMP) integrates transport with wider economic, infrastructure, social, housing and land use planning. The Master Plan will also inform future detailed plans, such as modal plans and specific Regional Transport Plans.

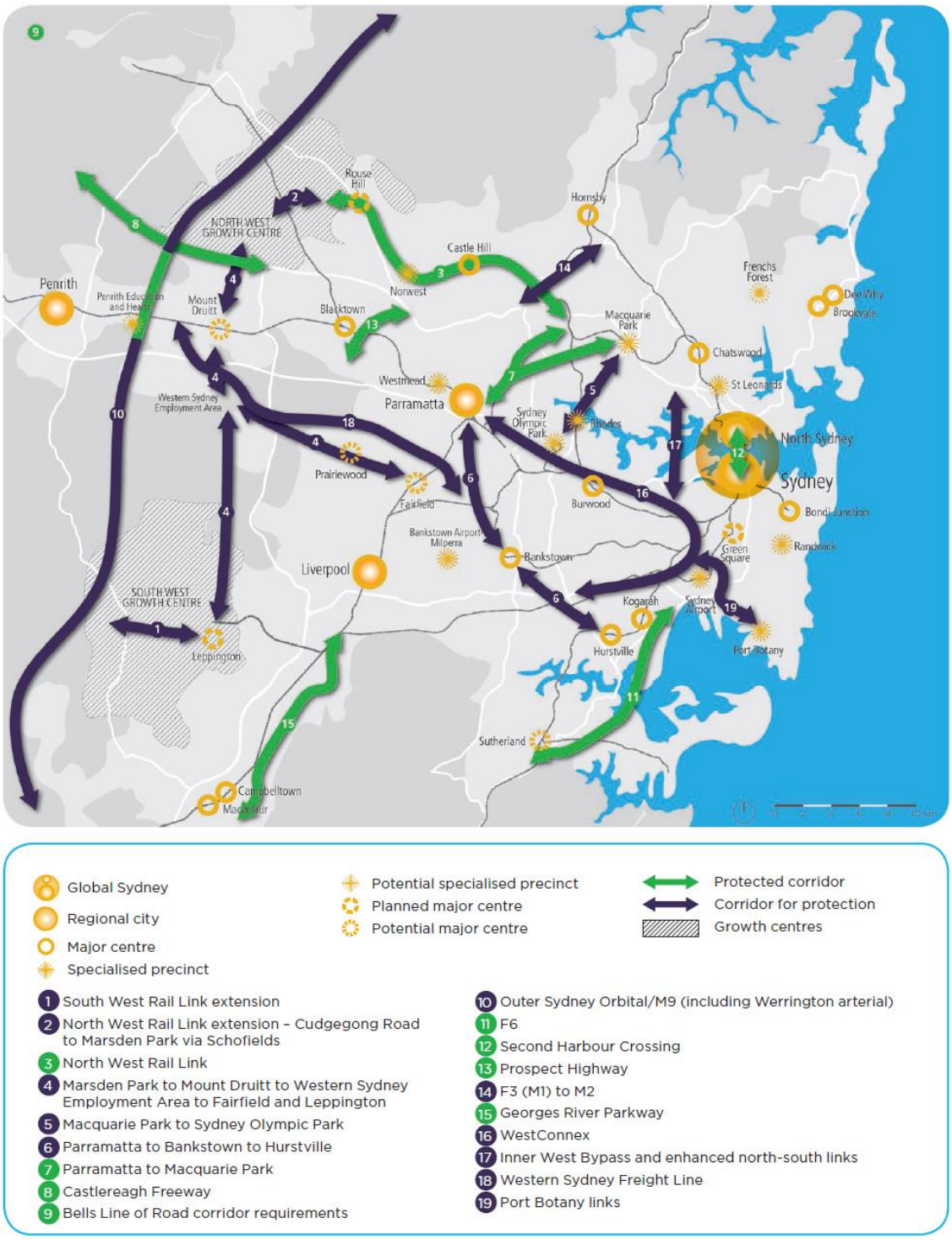
The LTTMP recognises that "*the fastest growing part of Greater Sydney is Western Sydney. Today, Western Sydney is home to 47 percent of Sydney's residents, and 37 percent of Sydney's jobs. Only around a quarter of these jobs are located in Western Sydney's centres, which means Western Sydney residents on average have to commute further than people elsewhere in Sydney. This challenge is increased by lower density development in much of Western Sydney, which increases car dependency and tends towards street-based public transport that can cover wider areas.*"

The LTTMP identifies the development of "*new transport connections for greenfield areas as they grow to support the North West and South West Growth Centres and the Western Sydney Employment Area by embedding public transport services and reducing car dependency which can limit transport access and increase vulnerability to oil price increases.*."

To meet the transport challenges in Western Sydney in the coming years, the LTTMP has outlined a number of actions using an integrated approach with the *Draft Metropolitan Strategy for Sydney to 2031*. These include:

- Public transport improvements to enhance links with jobs in Western Sydney, by redesigning the city-wide bus network to better complement rail, with the focus initially on the development of a strategic bus network that complements the rail network outlined in Sydney's Rail Future. The strategic bus network will consist of links with elevated service frequencies and on-road bus priority features that provide cross-regional connections between existing and emerging centres, including in Western Sydney. In particular, one of the actions incorporate the implementation of a Western Sydney bus and road upgrade package which incorporates "*optimising North West Rail Link access with bus priority on surrounding road networks, and improving road access to the South West and around Werrington to address social disadvantage in parts of Western Sydney*."
- New road projects, such as WestConnex, which is intended to improve links between Sydney Airport and Port Botany and Western Sydney, relieving pressure on the Eastern Distributor to the CBD.
- New intermodal freight terminals in South West and Western Sydney will enable a greater share of freight to be moved out of Port Botany by rail, also relieving pressure on roads.
- Identifying, preserving and protecting transport corridors, including the M9/Western Sydney Orbital, which is also identified in the LTTMP as a potential multi-modal corridor that would incorporate strategic freight road and rail links (refer to Figure 2.2).

Figure 2.2: Greater Sydney Transport Corridors for Preservation



Source: *NSW Long Term Transport Master Plan* (NSW Government, December 2012).

2.1.4 Broader Western Sydney Employment Area

The draft Broader Western Sydney Employment Area Structure Plan builds on previous plans for the Western Sydney Employment Area (WSEA) by expanding its coverage from 2,200 hectares to more than 10,000 hectares.

The Broader WSEA (BWSEA) has been identified in the Metropolitan Strategy for Sydney to 2031 as a "city-shaper" with the opportunity to influence Sydney's economic growth for the medium term. The BWSEA Draft Structure Plan has been developed to enable the area to contribute towards one of the stated goals of delivering 50 percent of Sydney's jobs growth to Western Sydney. Over the next 30 years, the BWSEA is expected to deliver 57,000 jobs, and over 200,000 jobs when fully developed.

The Draft Structure Plan designates a number of centres for the area, linked together and with the external network with road and rail connections that would carry vehicle, passenger and freight movements.

The BWSEA transport network is further discussed in Section 2.9.

2.1.5 Penrith Local Environmental Plan

The Penrith Local Environmental Plan (LEP) is a standard instrument that serves as the legal document guiding future development in the local government area.

Penrith City Council is in the process of preparing a single, City-wide LEP to replace all of its existing local planning documents, to be delivered in two stages:

- Stage 1 of the LEP process has been completed in 2010. This is now known as Penrith Local Environmental Plan 2010, and covers Penrith's rural and industrial areas, the St Marys Town Centre, and Penrith's heritage items and places.
- Stage 2 of the LEP covers Penrith's urban areas and will replace, but maintain the general intent, all the existing planning documents. Stage 2 also sets planning controls to serve as a planning framework for the next five years of anticipated urban growth in Penrith. These controls assist in delivering additional homes and jobs in new urban areas, the Penrith City Centre, St Marys Town Centre, and Kingswood (Penrith Health and Education Precinct).

The LEP also proposes to re-classify the zoning for a number of areas in Penrith to reflect more current development opportunities in terms of land use classification, to incorporate heritage items or to otherwise standardise the zone definitions and allowable uses.

The Sydney Science Park site is currently zoned as RU2 – Rural Landscape in the Penrith LEP 2010.

2.2 Site Context

The Sydney Science Park site in Luddenham is bound to the north by the Sydney Water Supply pipeline linking Warragamba Dam with the Prospect Reservoir, Luddenham Road to the west, and semi-rural residential and agricultural lands to the east and south, as shown in Figure 1.1.

Other major developments and land holdings surrounding the site include:

- the Erskine Park Employment Area and other precincts within the Broader Western Sydney Employment Area
- the Twin Creeks Golf and Country Club across Luddenham Road to the north east
- defence lands accessible via The Northern Road to the west
- Commonwealth lands to the south at Badgerys Creek, that would potentially accommodate Sydney's second airport
- The South West Growth Centre approximately 5 kilometres to the south.

The site itself lies towards the north west edge of the Broader Western Sydney Employment Area which is currently being planned to accommodate 57,000 new jobs over the next 30 years.[2]

The area of land surrounding Erskine Park between Mamre Road and Wallgrove Road is currently experiencing rapid redevelopment to industrial and business park uses, capitalising on the access opportunity provided by the Westlink M7 Motorway to its east and the M4 Western Motorway to its north east.

2.3 Existing Road Network

The road network surrounding the Sydney Science Park site is currently comprised of a number of arterial, sub-arterial and local roads. However, the large parcels of predominately rural land results in a limited road network connectivity through a lack of a fine grain local access road network in the vicinity of the Sydney Science Park site.

The key roads are shown in Figure 2.3, and include:

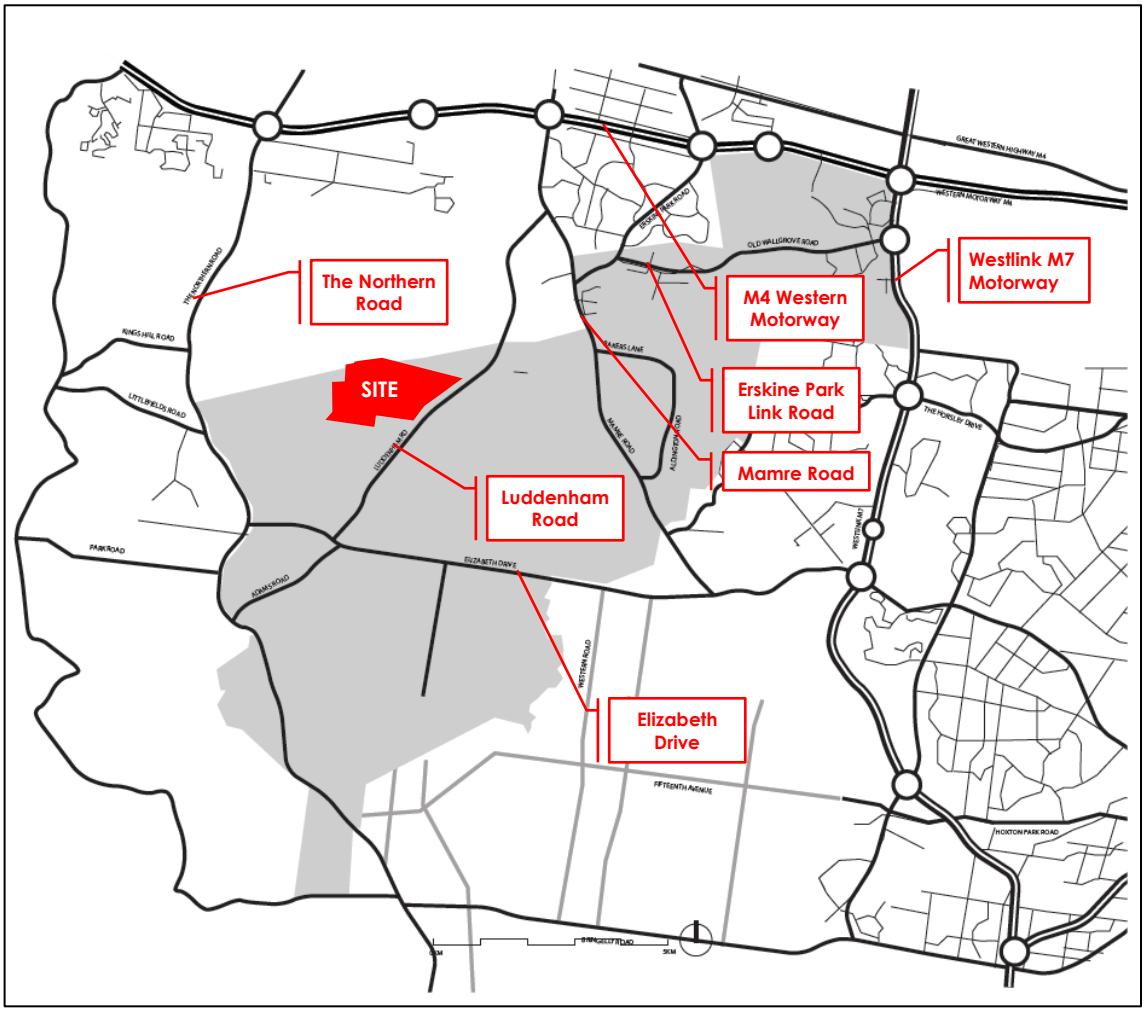
- Luddenham Road, which provides direct access to the site
- Mamre Road, functioning as a sub-arterial road linking Elizabeth Drive to the south with the Western Motorway (M4) and the Great Western Highway (A44) to the north
- Elizabeth Drive, running east-west approximately 3.6 kilometres to the south of the site and linking The Northern Road (A9) to the west with the Westlink M7 Motorway and further up to the Hume Highway (A28) in Liverpool to the east.

Other strategic road links in the surrounding areas include:

- Westlink M7 motorway
- Western Motorway (M4)
- The Northern Road
- Erskine Park Link Road – Lenore Lane.

[2] Broader Western Sydney Employment Area, Draft Structure Plan (June 2013).

Figure 2.3: Surrounding Road Network



Basemap Source: *Broader Western Sydney Employment Area Structure Plan: Transport Planning – Preliminary Analysis Report, Exhibition Draft* (GHD, June 2013)

Mamre Road

Mamre Road functions as a sub-arterial road aligned in a north-south orientation, and linking with the Great Western Highway (A44) in St Marys to the north, to Elizabeth Drive in Kemps Creek to the south, linking with the M4 Motorway and Erskine Park Link Road.

It is a two-way road configured with a 2-lane, 7-metre wide carriageway, set within an approximately 45-metre wide road reserve.

Mamre Road is shown in Figure 2.4 and carries approximately 15,000 vehicles per day[3].

3 Based on the peak hour traffic counts undertaken by RMS in February 2005 and assuming a peak-to-daily ratio of 8% for arterial roads and 10% for local roads.

Figure 2.4: Mamre Road (looking north)

Luddenham Road

Luddenham Road functions as a collector road. In the vicinity of the site Luddenham Road is aligned in a general north-east/south-west direction. It is a two-way road configured with a 2-lane, 7 metre wide carriageway, set within an approximately 21 metre wide road reserve.

Luddenham Road is shown in Figure 2.5 and carries approximately 3,000 vehicles per day[4].

Figure 2.5: Luddenham Road (looking north)

4 Based on the peak hour traffic counts undertaken by RMS in March 2005 and assuming a peak-to-daily ratio of 8% for arterial roads and 10% for local roads.

2.4 Surrounding Intersections

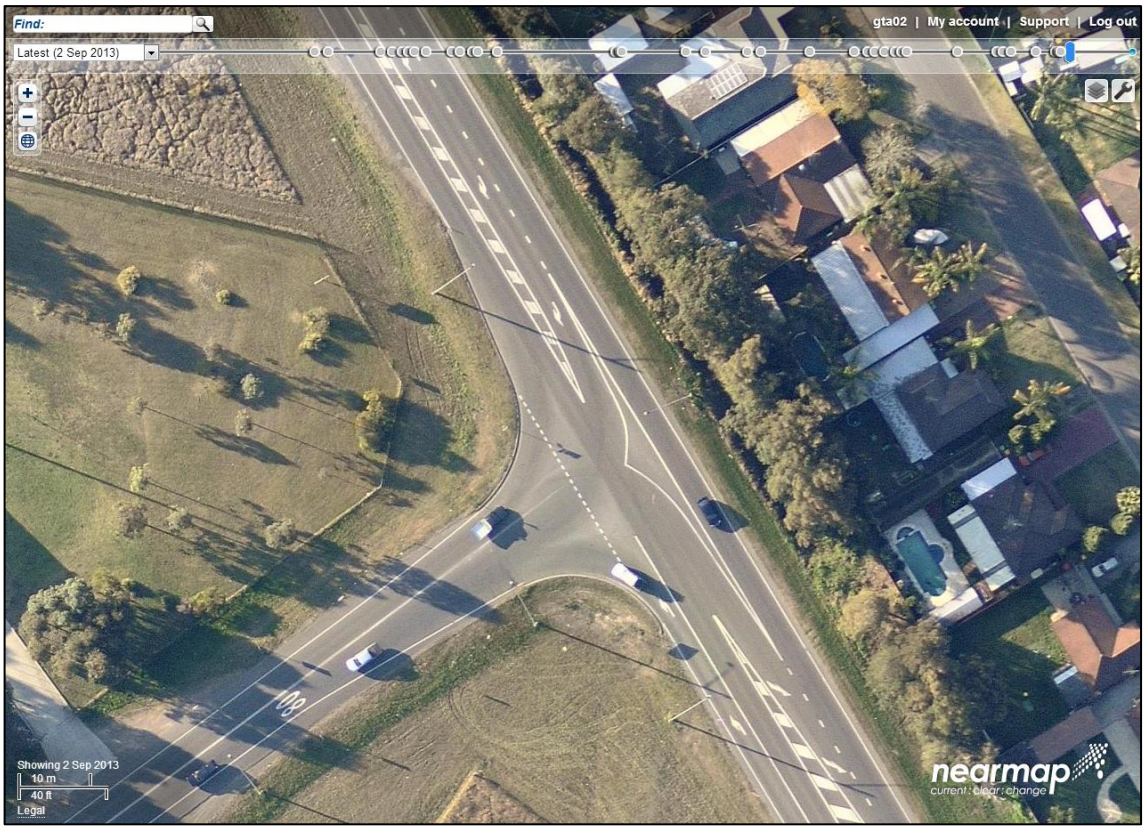
Access to the Sydney Science Park site from the north and east would traverse the Luddenham Road/Mamre Road intersection. From the south, access would traverse the Luddenham Road/Elizabeth Drive intersection.

Mamre Road / Luddenham Road intersection

Figure 2.6 and Figure 2.7 show views of the Mamre Road/Luddenham Road intersection. Figure 2.6 shows and aerial view while Figure 2.7 shows a street-level view from the southbound direction along Mamre Road approaching the intersection.

The intersection is laid out following a seagull configuration, with priority given to through flows on Mamre Road.

Figure 2.6: Mamre Road/Luddenham Road intersection – aerial view



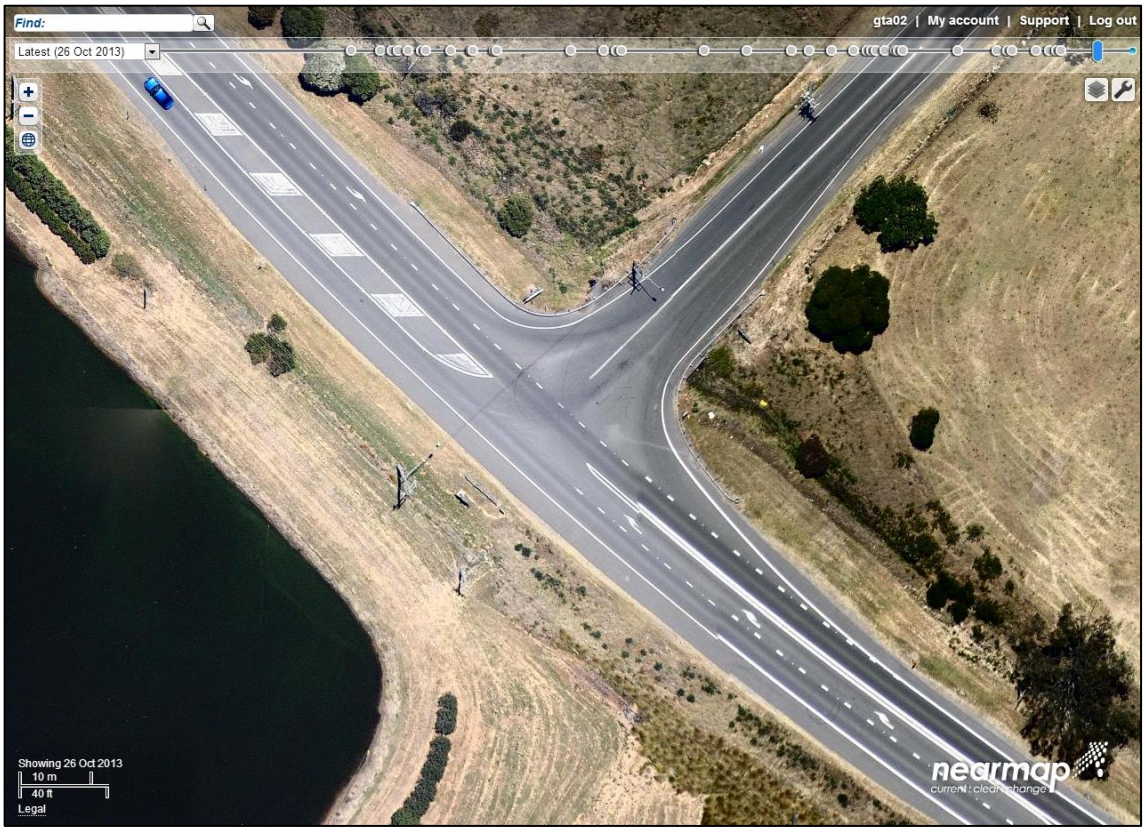
Source: Nearmap

Figure 2.7: Mamre Road/Luddenham Road intersection – viewed from Mamre Road north

Luddenham Road/Elizabeth Drive Intersection

Figure 2.8 and Figure 2.9 show views of the Luddenham Road/Elizabeth Drive intersection. It is a priority-controlled T-intersection with separate turn lanes provided on both approaches from Elizabeth Drive. Figure 2.10 shows an aerial view while Figure 2.11 shows a street-level view from eastbound Elizabeth Drive approaching the intersection.

Figure 2.8: Luddenham Road/Elizabeth Drive Intersection – aerial view



Source: Nearmap

Figure 2.9: Luddenham Road/Elizabeth Drive Intersection – viewed from Elizabeth Drive west

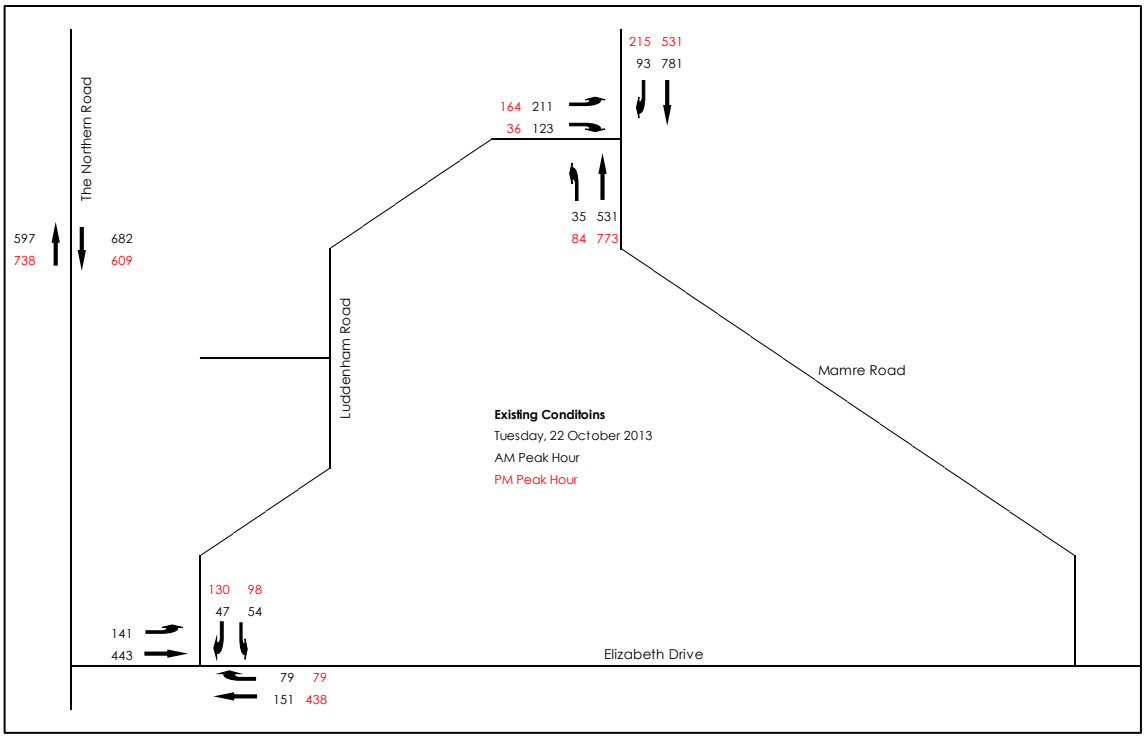
2.5 Existing Traffic Conditions

GTA Consultants commissioned traffic movement on key roads in the vicinity of the site on Tuesday, 22 October 2013 during the following peak periods:

- 6:00am and 9:00am
- 3:00pm and 6:00pm.

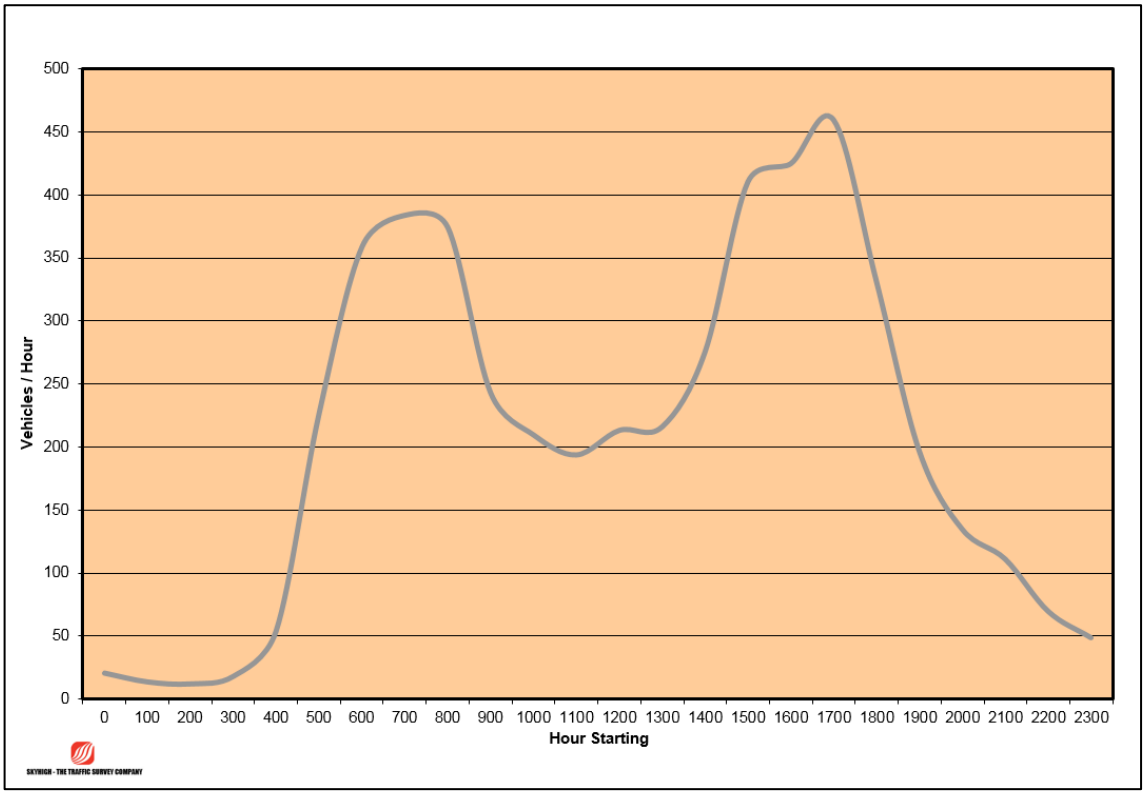
The AM and PM peak hour traffic volumes are summarised in Figure 2.10, with full results contained in Appendix A.

Figure 2.10: Existing AM / PM Peak Hour Traffic Volumes



GTA Consultants also commissioned a 7-day mid-block (tube) count on Luddenham Road between 22 and 28 October 2013. A summary of the average weekday traffic volumes over an average day is shown in Figure 2.11.

Figure 2.11: Luddenham Road 7-day Mid-Block Traffic Volumes (22-28 28 October 2013)



Source: Skyhigh Traffic Data

2.6 Existing Intersection Operation

The operation of the key intersections within the study area have been assessed using SIDRA INTERSECTION[5], a computer based modelling package which calculates intersection performance.

The commonly used measure of intersection performance, as defined by the Roads and Maritime Services (RMS), is vehicle delay. SIDRA INTERSECTION determines the average delay that vehicles encounter and provides a measure of the level of service.

Table 2.1 shows the criteria that SIDRA INTERSECTION adopts in assessing the level of service.

[5] Program used under license from Akcelik & Associates Pty Ltd.

Table 2.1: SIDRA INTERSECTION Level of Service Criteria

Level of Service (LOS)	Average Delay per vehicle (seconds/vehicle)	Traffic Signals, Roundabout	Give Way & Stop Sign
A	Less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Near capacity	Near capacity, accident study required
E	57 to 70	At capacity, at signals incidents will cause excessive delays	At capacity, requires other control mode
F	Greater than 70	Extra capacity required	Extreme delay, major treatment required

Table 2.2 presents a summary of the existing operation of the intersection, with full results presented in Appendix B of this report.

Table 2.2: Existing Operating Conditions

Intersection	Peak	Leg	Degree of Saturation (DOS)	Average Delay (sec)	95th Percentile Queue (m)	Level of Service (LOS)
Luddenham Road/ Mamre Road	AM	South	0.31	1	0	A
		North	0.45	2	4	A
		West	0.66	24	36	B
	PM	South	0.44	1	0	A
		North	0.34	5	2	A
		West	0.64	30	27	C
Luddenham Road/ Elizabeth Drive	AM	East	0.15	5	4	A
		North	0.12	17	3	B
		West	0.26	3	0	A
	PM	East	0.25	2	3	A
		North	0.30	16	10	B
		West	0.09	3	0	A

On the basis of the above assessment, it is evident that both the Luddenham Road/Mamre Road and the Luddenham Road/Elizabeth Drive intersections currently operate within acceptable limits, with minimal queues and delays on all approaches.

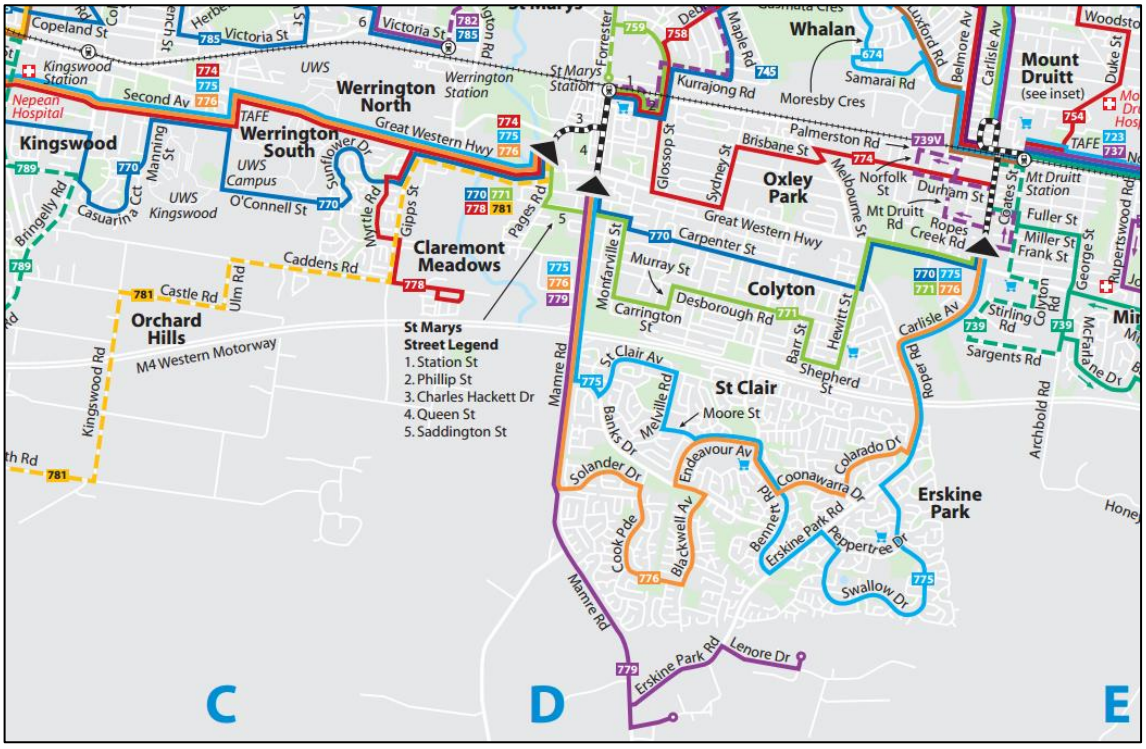
2.7 Public Transport

The site is within Metropolitan Bus Contract Region 1, currently being operated by Busways.

A review of the public transport available in the vicinity of the site indicates that aside from Bus Route 779 between St Marys and the Erskine Park Industrial Area running along Mamre Road past the Luddenham Road Intersection, only a daily school bus service runs along Luddenham Road.

In general it can be concluded that the existing Sydney Science Park site is currently under-serviced by public transport. However the level of service provision reflects the low travel demands of the locality.

Figure 2.12: Existing Bus Network



Source: Busways

2.8 Pedestrian and Cycling Infrastructure

There is currently limited pedestrian or cyclist infrastructure provided in the vicinity of the site, mainly due to the nature of land uses in the vicinity and the limited demand for such facilities at present.

2.9 Future BWSEA Transport Infrastructure

2.9.1 The Draft Structure Plan

The Broader Western Sydney Employment Area (BWSEA) draft Structure Plan has been developed by the NSW Department of Planning and Infrastructure in line with the goals and priorities identified in the following documents:

- NSW 2021 A Plan to Make NSW Number One; and
- Draft Metropolitan Strategy for Sydney by 2031.

The draft BWSEA Structure Plan identifies that:

- Transport, movement and access are critical to the success of an employment area.
- Movement and access covers a broad range of considerations, which include road access and freight networks, rail access (passenger and freight) public transport and active transport.

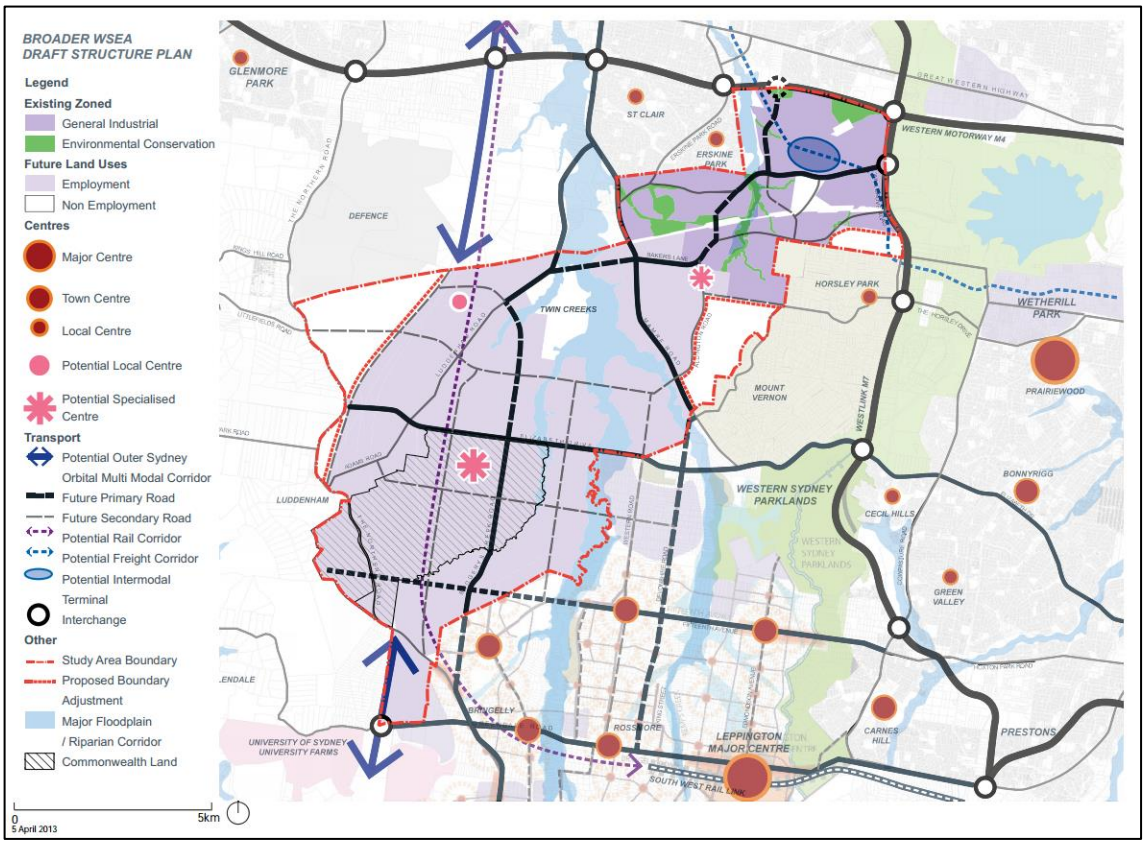
The draft BSWEA Structure Plan has been developed with key transport infrastructure elements including:

- Outer Sydney Orbital (OSO) corridor

- Road network
- Freight rail line
- Passenger rail line
- Centres (major, town and local).

The Draft BWSEA Structure Plan is shown in Figure 2.13.

Figure 2.13: Draft Broader Western Sydney Employment Area Structure Plan



Source: Department of Planning and Infrastructure website

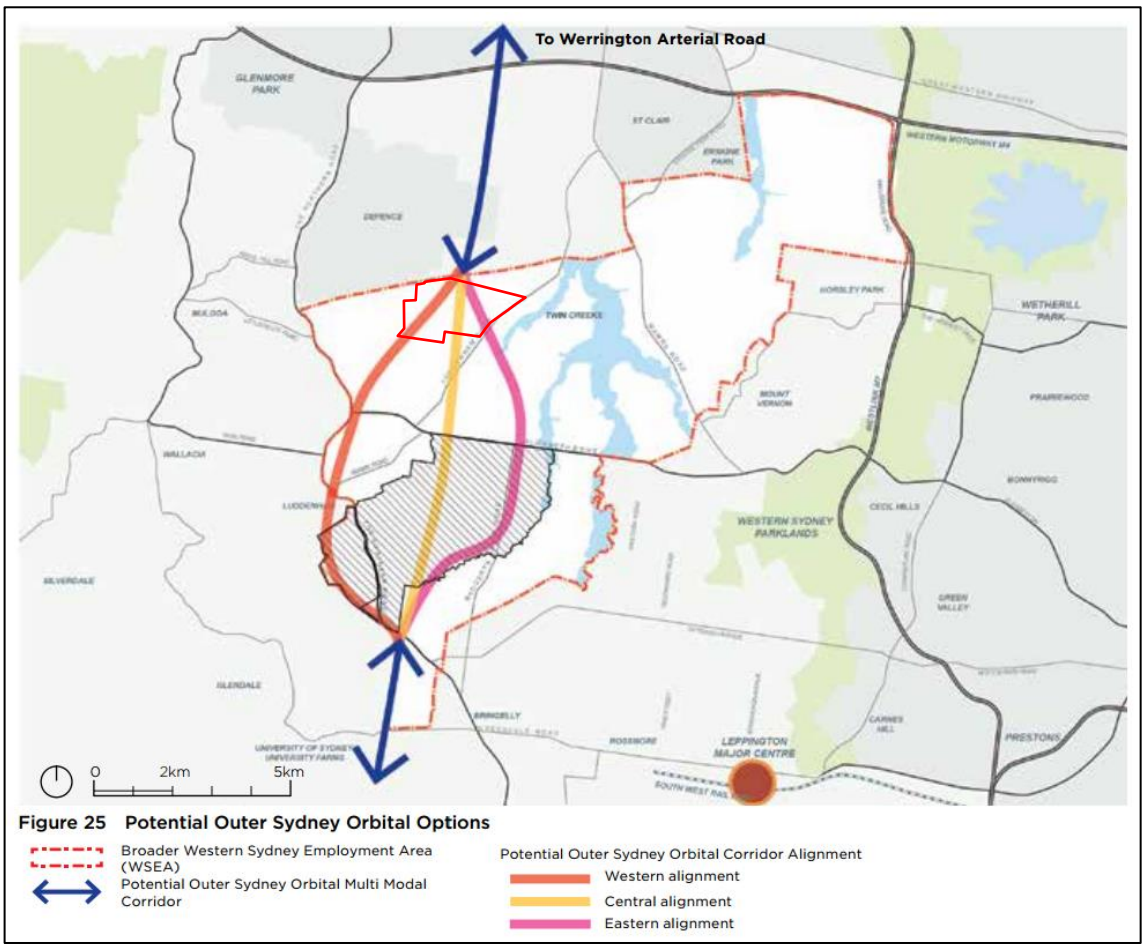
2.9.2 Road Network Improvements

A key principle of the draft Structure Plan is the development of an efficient road network with strategic links into to the existing road network with direct access to local centres as well as direct heavy vehicle links to key freight corridors.

A key component is the preservation of an Outer Sydney Orbital (OSO) corridor which was identified in the NSW Long Term Transport Master Plan and draft Metropolitan Strategy for Sydney to 2031. The precise location of the corridor is subject to further investigations. However, as shown in Figure 2.14, potential OSO corridor options run through or adjacent to the Sydney Science Park site.

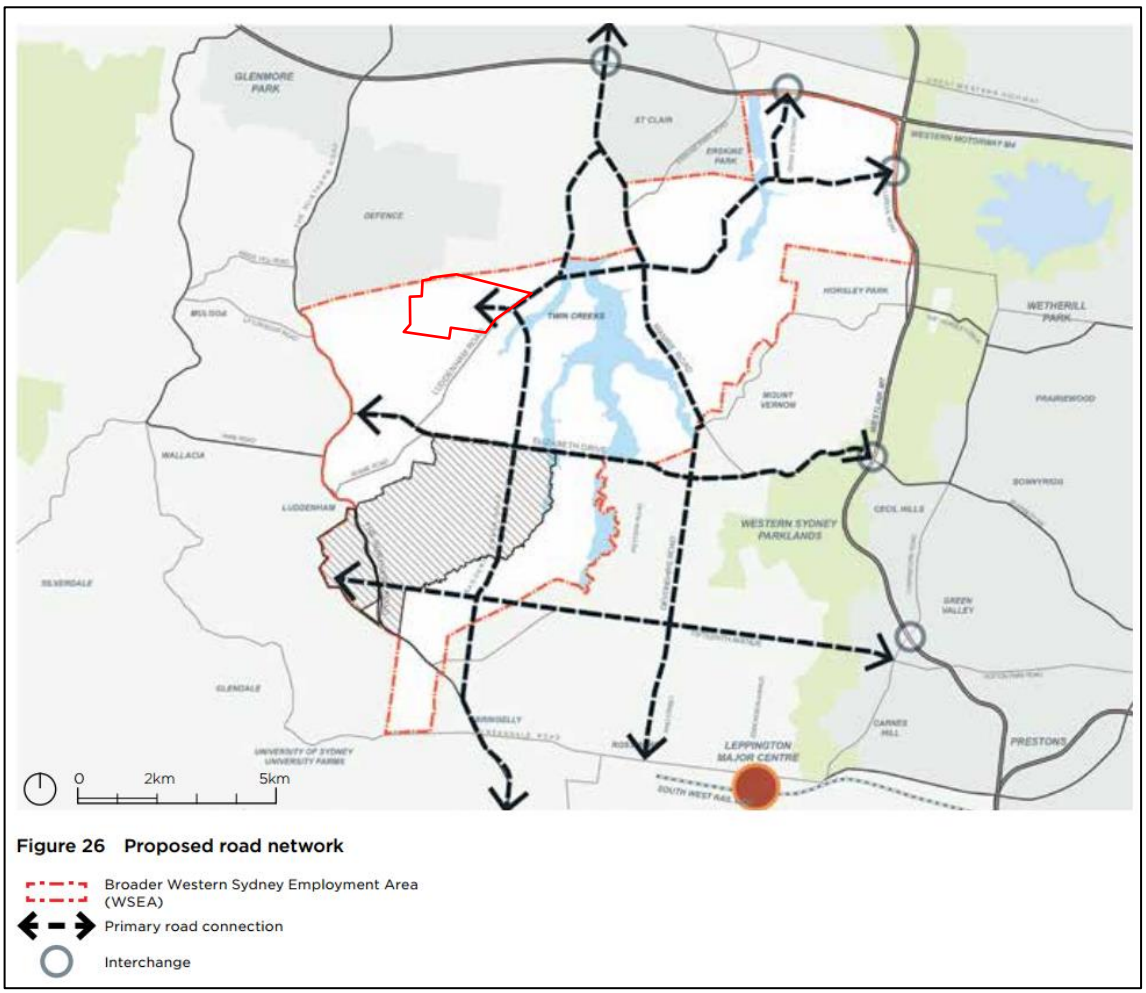
The OSO corridor would be supported with an interconnected road network as shown in Figure 2.15. Key elements include east-west connections between the OSO and the M7 Motorway and north south connections between the M4 Motorway and Elizabeth Drive.

Figure 2.14: Potential Alignment Options for the Outer Sydney Orbital



Source: *Draft Broader Western Sydney Employment Area Structure Plan* (Department of Planning and Infrastructure, 2013)

Figure 2.15: BWSEA Proposed Road Network



Source: *Draft Broader Western Sydney Employment Area Structure Plan* (Department of Planning and Infrastructure, 2013)

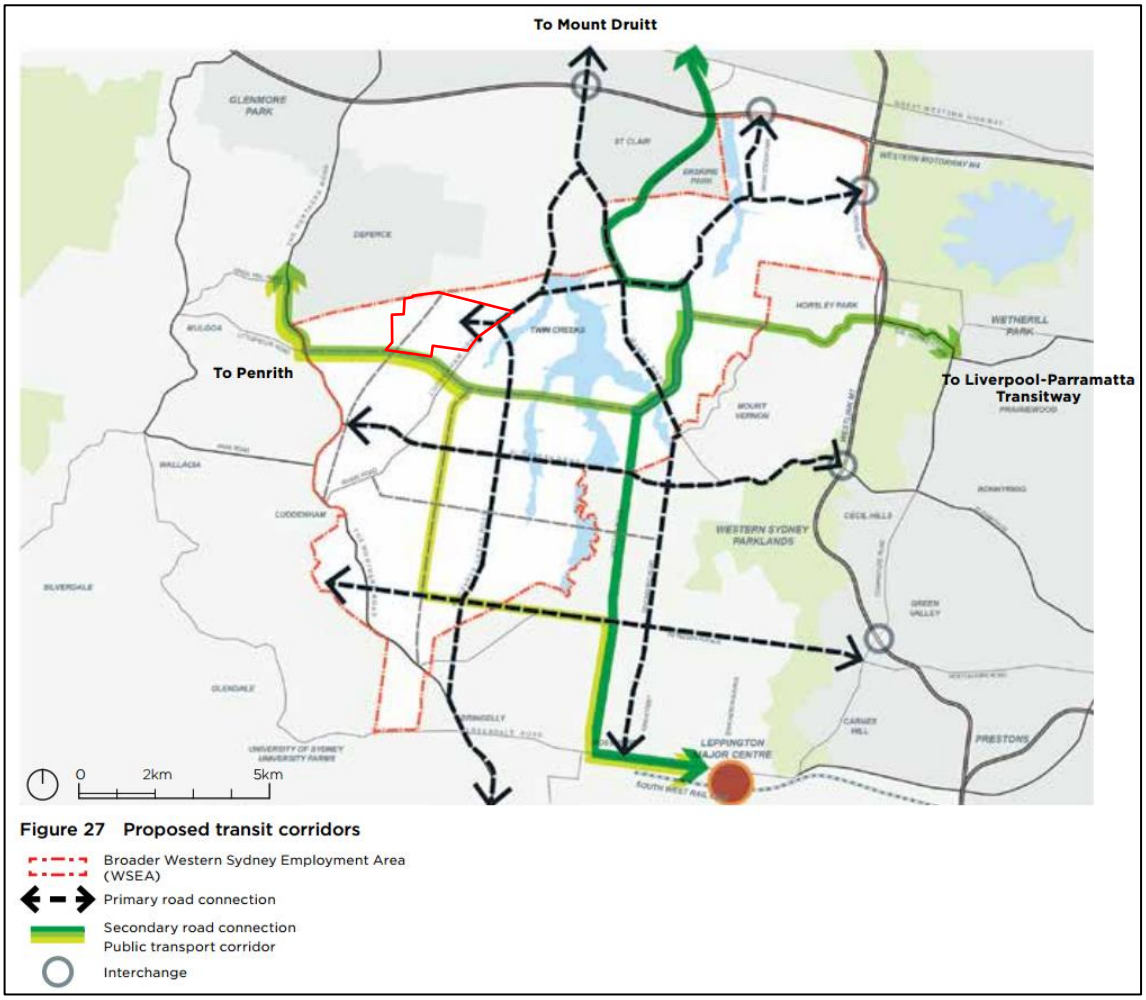
2.9.3 Rail and Public Transport Corridors

The draft Structure Plan has identified passenger rail, freight rail and public transport corridors within BWSEA. These lines and corridors seek to connect centres within the BWSEA and beyond.

These connections are shown in Figure 2.16 and in Figure 2.17.

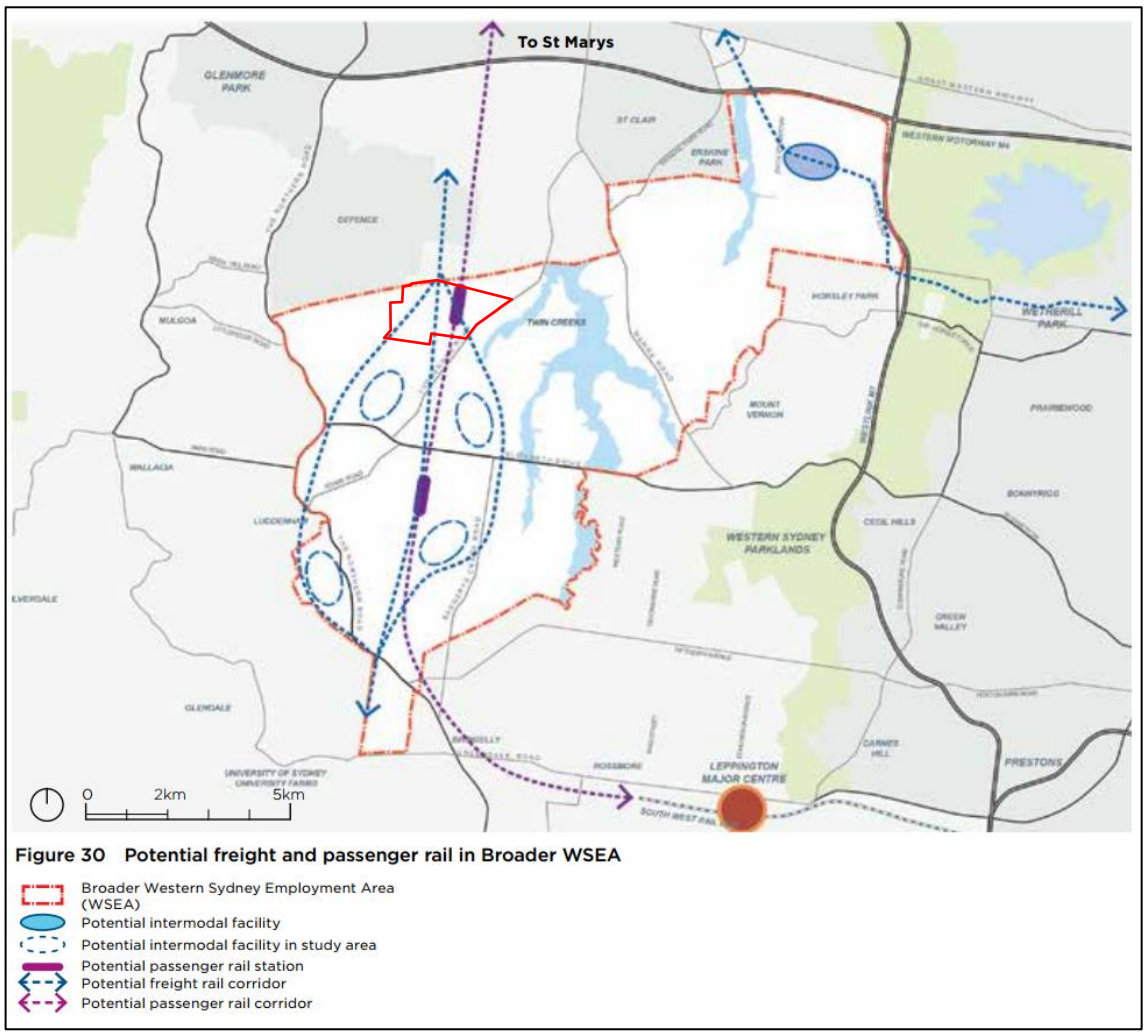
As shown in these figures, a potential rail station and connecting public transport corridor is proposed at Luddenham within the Sydney Science Park Science. Accordingly, the Draft BWSEA Structure Plan has identified a local centre to be located within the Sydney Science Park site around this potential transport hub (see Figure 2.18).

Figure 2.16: BWSEA Proposed Transit Corridors



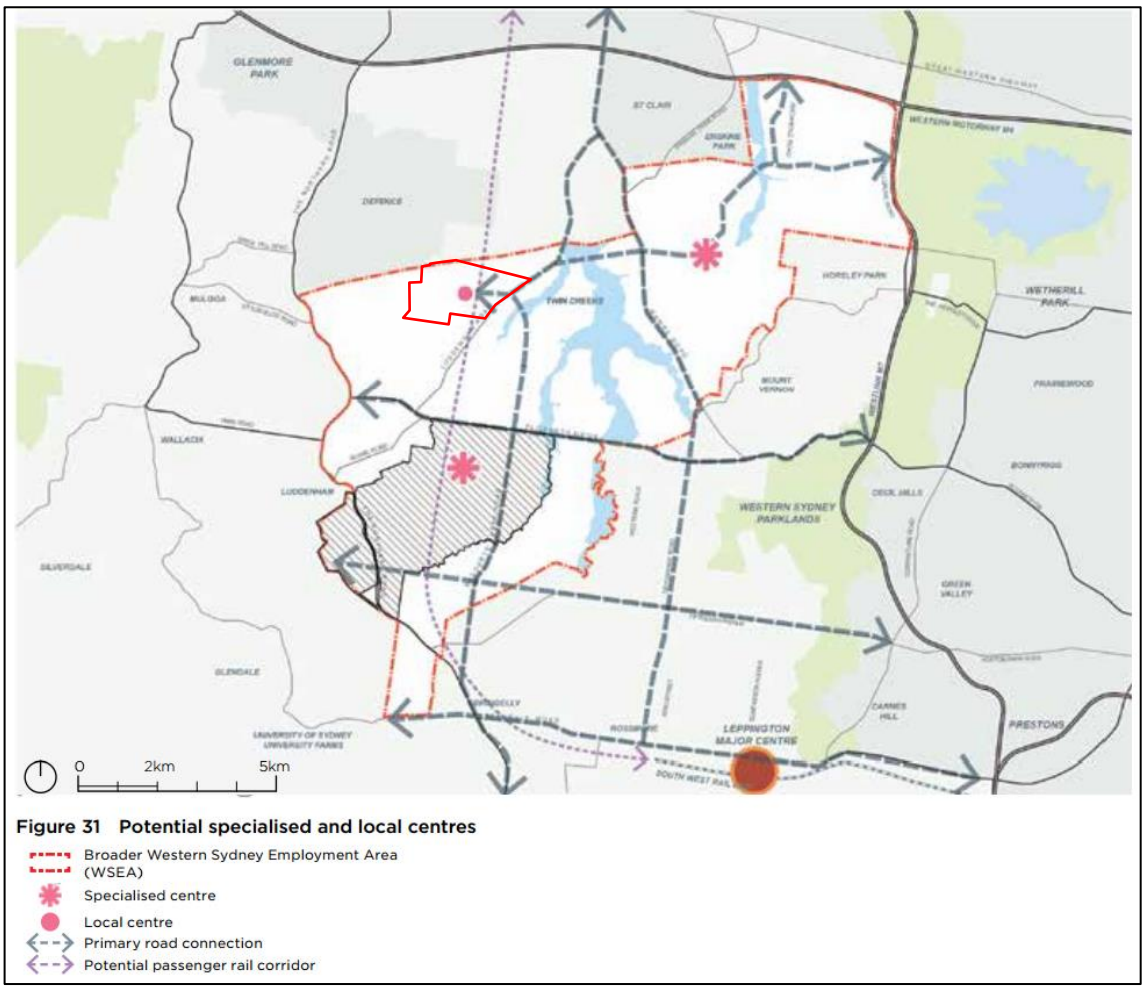
Source: *Draft Broader Western Sydney Employment Area Structure Plan* (Department of Planning and Infrastructure, 2013)

Figure 2.17: Potential BWSEA Freight and Passenger Rail Links



Source: *Draft Broader Western Sydney Employment Area Structure Plan* (Department of Planning and Infrastructure, 2013)

Figure 2.18: Potential BWSEA Specialised and Localised Centres



Source: *Draft Broader Western Sydney Employment Area Structure Plan* (Department of Planning and Infrastructure, 2013)

2.9.4 Transport Implications of Draft BWSEA Structure Plan to Sydney Science Park

As noted above the potential rail, public transport and road network corridors run through or adjacent to the Sydney Science Park site. The development of the site within the context of these corridors and the associated local centres will need to be carefully planned to accommodate the transport objectives set out in the draft Structure Plan.

Notwithstanding the Sydney Science Park development proposal has potential to realise these objectives, promoting the development of the infrastructure in a timely and meaningful manner. The provisions for these corridors within the Sydney Science Park development proposal are described in Section 3 of this report.

Being part of BWSEA, it is envisaged that the Sydney Science Park development will be party to funding the development of BWSEA transport infrastructure through State Infrastructure Contribution (SIC) levies.

3. Overview of Sydney Science Park Planning Proposal

3.1 Proposed Land Uses

The Sydney Science Park Planning Proposal comprises a mix of research and scientific-based employment, educational and residential uses, supported by local retail and recreational facilities.

In terms of land use planning, there are three main categories of land use that are proposed within the site: Mixed Use, Open Space and Sports and Recreation. The provision of general Mixed Use zones allows flexibility for the development to respond to market demands of various land use. Two key nodes will be established – the "City Road" precinct that will deliver finer grain uses such as retail, office, education and higher density residential options. The "Commercial Road" precinct will be of coarser grain uses such as commercial and research and development facilities.

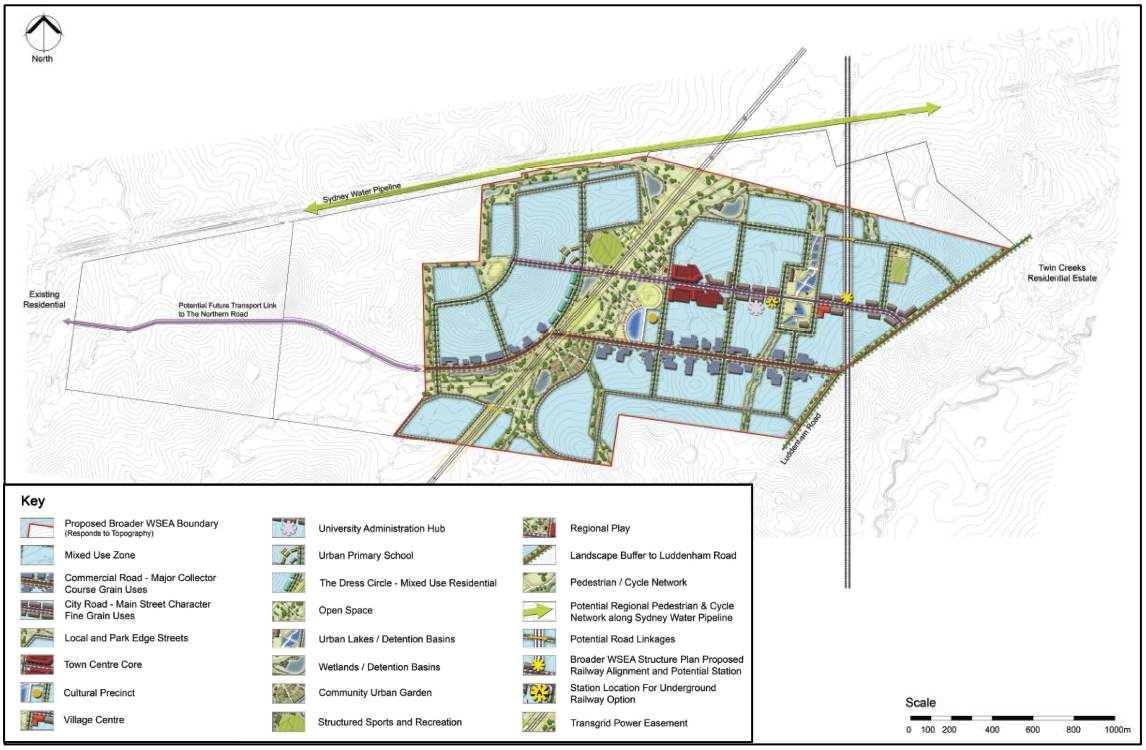
The overall open space will combine riparian corridors, drainage and water management reserves and recreational areas that have both passive and active functions.

The ultimate development yield of land uses that could be attained by 2041 within the Sydney Science Park is summarised in Table 3.1, with the Master Plan shown in Figure 3.1.

Table 3.1: Development Schedule

Use	Size
Employment	340,000 m^2 GFA
Education	100,000 m^2 GFA
Local Retail	30,000 m^2 GLFA
Detached housing	300 dwellings
Terrace housing/townhouse	1,200 dwellings
Apartments	1,500 dwellings
Student accommodation	400 dwellings

Figure 3.1: Sydney Science Park Master Plan



Source: DesignIQ for EJC.

3.2 Future Transport Corridors

The Sydney Science Park Master Plan shows the provisions for a future public transport and road corridor running north south through the eastern portion of the site. This is generally consistent with the draft BWSEA Structure Plan alignments.

The Master Plan indicates that a future rail extension has been provided for with the potential of a station being located centrally to the site. Three provisional corridors for the potential future M9 Orbital have been addressed in the master plan to provide for a flexible approach in its ultimate location.

It is envisaged that the Transport Corridor would have the potential to accommodate the following:

- an arterial road
- passenger rail line
- freight rail line.

It is understood that the corridor options, all of which pass through the Sydney Science Park site at Luddenham, reflect the potential for a Badgerys Creek Airport.

Discussions between GTA Consultants and TfNSW have indicated that:

- TfNSW stated the no assessment or design of route options has been undertaken. The alignments shown in the structure plan should be considered "in principle" alignments.
- TfNSW is about to commence route alignment studies but they are at least 2 years away from determining a route / corridor.

- Rail lines as shown are not in the Transport Master Plan and thus have no current status or funding.
- Road and rail in a combined corridor would be considered the preferred outcome but would be subject to detailed assessment.

To assist with the site planning, GTA Consultants undertook a preliminary analysis of potential corridor options. The process and findings are described below.

3.2.1 Purpose of GTA's Conceptual Corridor Options Assessment

In the absence of information and design considerations for a future OSO from TfNSW or DP&I, GTA has undertaken conceptual corridor option assessment to inform the site planning of the Sydney Science Park planning proposal.

It is the intention that the information provided in this assessment be used to make provision for a transport corridor through the Sydney Science Park to accommodate a future OSO.

3.2.2 Corridor Identification Assumptions

The development of the conceptual Transport Corridor alignments has been based on the following information:

- aerial photography provided by Nearmap and Google Maps
- contour information sourced from http://nratlas.nsw.gov.au
- lot boundary information sourced from http://maps.six.nsw.gov.au
- indicative alignments shown in the WSEA Structure Plan.

It is noted that a site inspection of the corridor alignments has not been undertaken.

Set out points for the corridors have been based around the following:

- Northern end:
  - Road link to the Werrington Road arterial which is planned to run between the Great Western Highway and the M4 Motorway
  - The Western Rail line adjacent to St Marys station.
- Southern end:
  - South West Rail link at Leppington / Rossmore
  - Road linkages to the Northern Road.

The road corridor alignments have been considered with and without an adjoining rail corridor. If separate road and rail corridors are to be pursued then there is potential to utilise existing road alignments such as the Northern Road, Badgerys Creek Road or Luddenham Road.

3.2.3 Corridor Width Assumptions

The widths required for an OSO transport corridors have been reviewed taking into account examples and precedents of Sydney's other transport corridors.

Most notably a corridor width of 100 metres was assigned for the OSO Corridor along the Boundary Road corridor in Box Hill.

Notwithstanding the above, we have worked on the following corridor widths:

- Road Only Corridor = 60 metres
- Rail Only Corridor = 40 metres

- Road + Rail Corridor = 100 metres

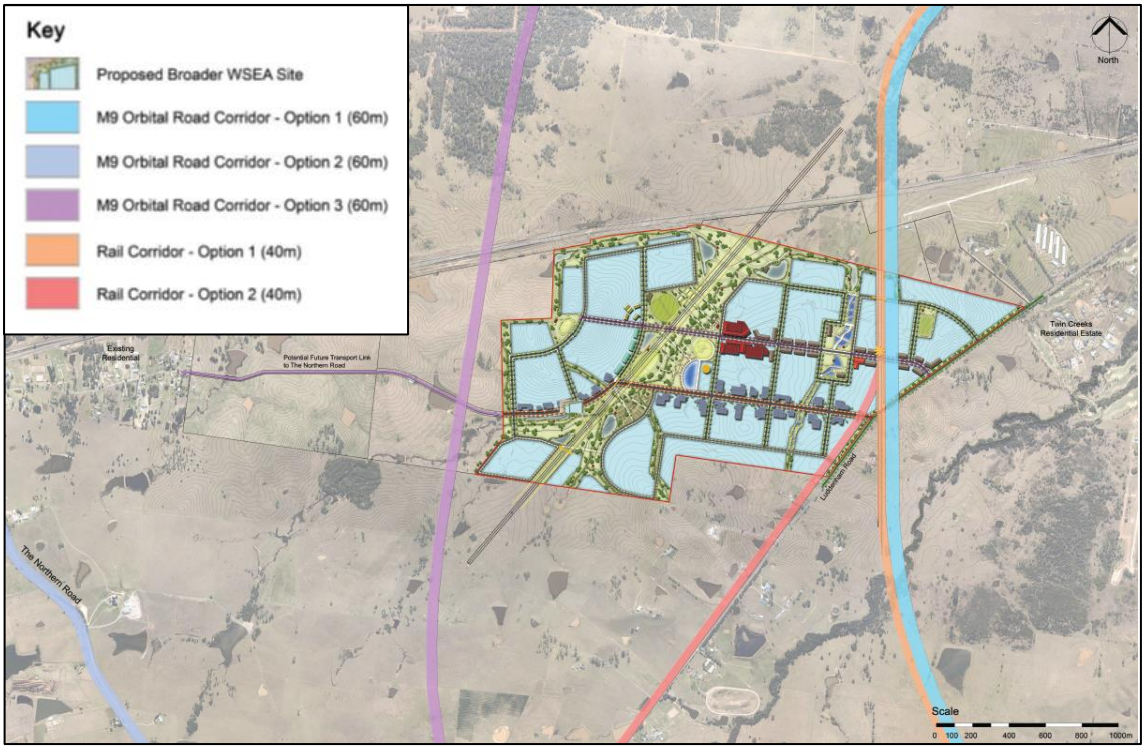
3.2.4 Conceptual Corridors Identified

The various corridors identified as part of this assessment are shown in Figure 3.2. The road corridor options include the duplication of the Northern Road.

It is noted that there is also potential to utilise Luddenham Road as a Road Corridor with or without an adjacent rail corridor.

It is noted that there would potential to consider locating the transport corridor underground or on an elevated structure. The provision of an underground corridor (particularly passenger rail lines) would be a preferred outcome as it would facilitate improved integration of the corridor and the land uses within the "centre".

Figure 3.2: Alignment Options for Major Transport Corridors



3.3 Development Staging

The development of the Sydney Science Park would be undertaken in stages. The indicative yields of the development components are broken down into five-year periods in Table 3.2.

Table 3.2: Proposed Development Staging

Use	Units	Size					
		2016	2021	2026	2031	2036	2041
Employment	m² GFA	10,000	50,000	120,000	190,000	290,000	340,000
Education	m² GFA		10,000	30,000	60,000	80,000	100,000
Local Retail	m² GLFA		7,000	12,000	18,000	18,000	30,000
Detached housing	dwellings		50	150	225	300	300
Terrace housing/townhouse	dwellings		50	300	850	1,200	1,200
Apartments	dwellings		50	450	575	875	1,500
Student accommodation	dwellings		50	125	200	300	400

3.4 Internal Road Network

The Sydney Science Park internal key road network would be comprised of a functional hierarchy of roads that are laid out in a general grid structure, and adjusted to account for local site constraints such as riparian corridors and topography. This would enable the provision of legible street patterns that deliver flexibility in responding to multiple land use forms in a mixed use environment. The key internal roads are located to follow subtle natural contours and take advantage of the site's natural assets such as riparian corridors and ridge tops.

Roads generally to run perpendicular to contours – providing for frequent views and deliver better site management, and are orientated to maximise ESD principles.

The streets will create a legible network of vehicular, pedestrian and bike linkages forming a hierarchy that reinforce arrival and destination points, public realm and built form. Collector roads will be designed to cater for cycle ways, major pedestrian networks and potential future public transport.

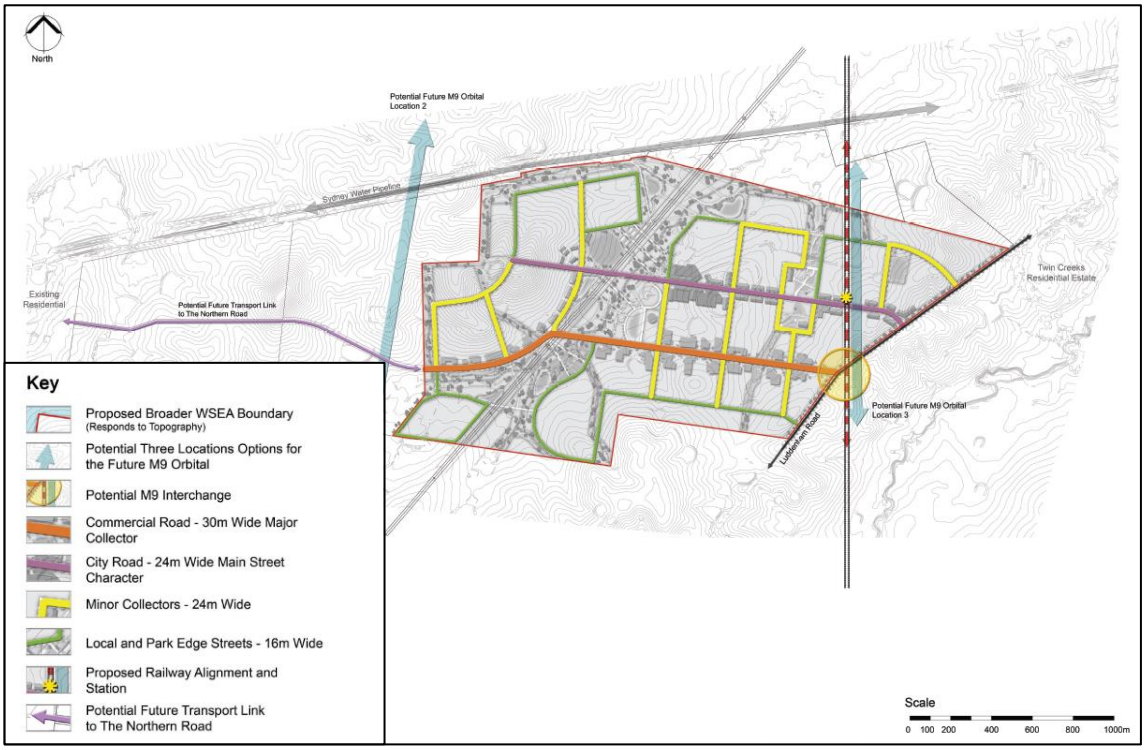
Two major east-west link roads linked with Luddenham Road will deliver two distinct functions and character:

- the "City Road" will have a 24 metre right of way and intended to deliver finer grain land uses. It will have a main street character with activated frontages and a pedestrian focus. It will also be the main link to the future proposed rail station.
- The "Commercial Road", with a 30 metre right of way running east-west approximately 300 metres to the south of City Road, will provide for coarser grain land uses and will function as the major transport road within the site.

A finer grain network of local roads would provide local access within each precinct.

Figure 3.3 shows the proposed internal road network for the site.

Figure 3.3: Sydney Science Park Internal Road Network



Source: DesignIQ for EJC.

3.5 Public Transport Network

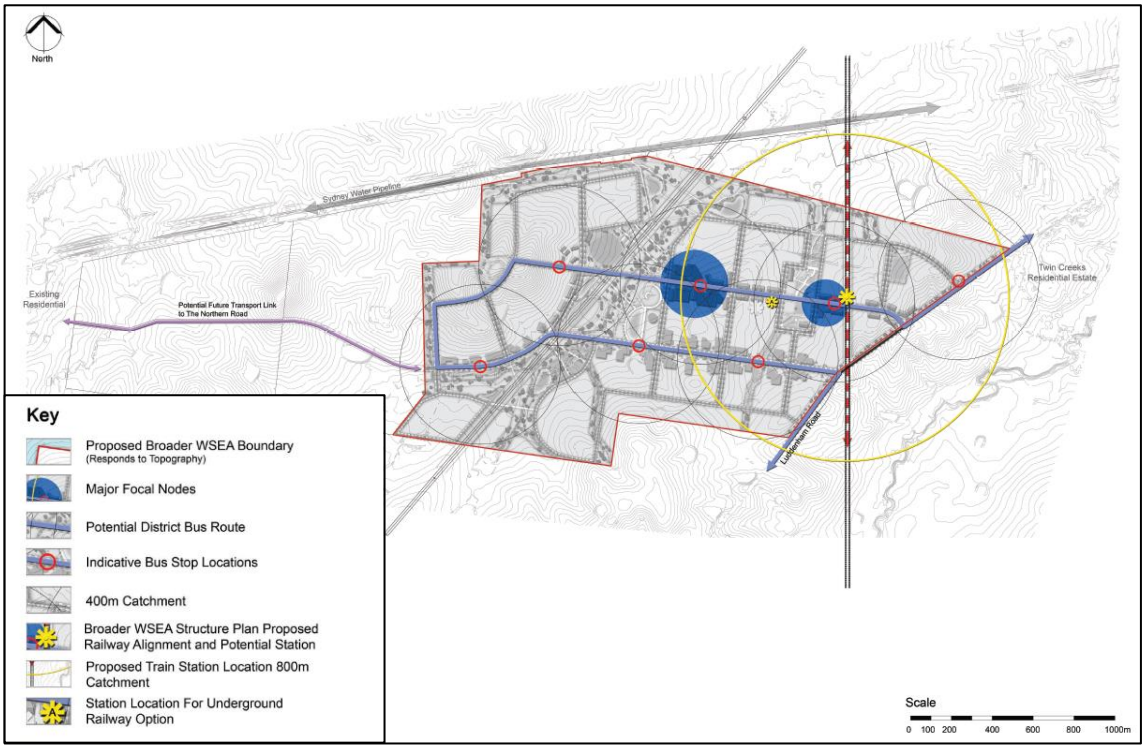
Provision will be made along the two major east west link roads, City Road and Commercial Road to provide for the primary bus route in Sydney Science Park. The proposed bus route will link major facilities and provide access to a future rail station, and allows for a potential future extension to link with The Northern Road.

Bus stop locations will be placed to maximise a 400 metre walkable catchment.

City Road, with its finer grain land uses, has been orientated to focus onto the potential future railway station location, which has been placed to maximise both the 400-metre and 800-metre walk catchments.

Figure 3.4 shows the proposed structure of the public transport network for Sydney Science Park.

Figure 3.4: Proposed Public Transport Network



Source: DesignIQ for EJC.

3.6 Pedestrian and Cycle Facilities

A network of pedestrian and cycle facilities is proposed to be provided as part of the Planning Proposal, in order to promote active transport and contribute towards reducing private car trips, in line with overall State planning objectives and targets.

The networks and facilities will be designed to be safe and well-connected, to also function as a healthy option for the community, including employees, residents, students and visitors to the site.

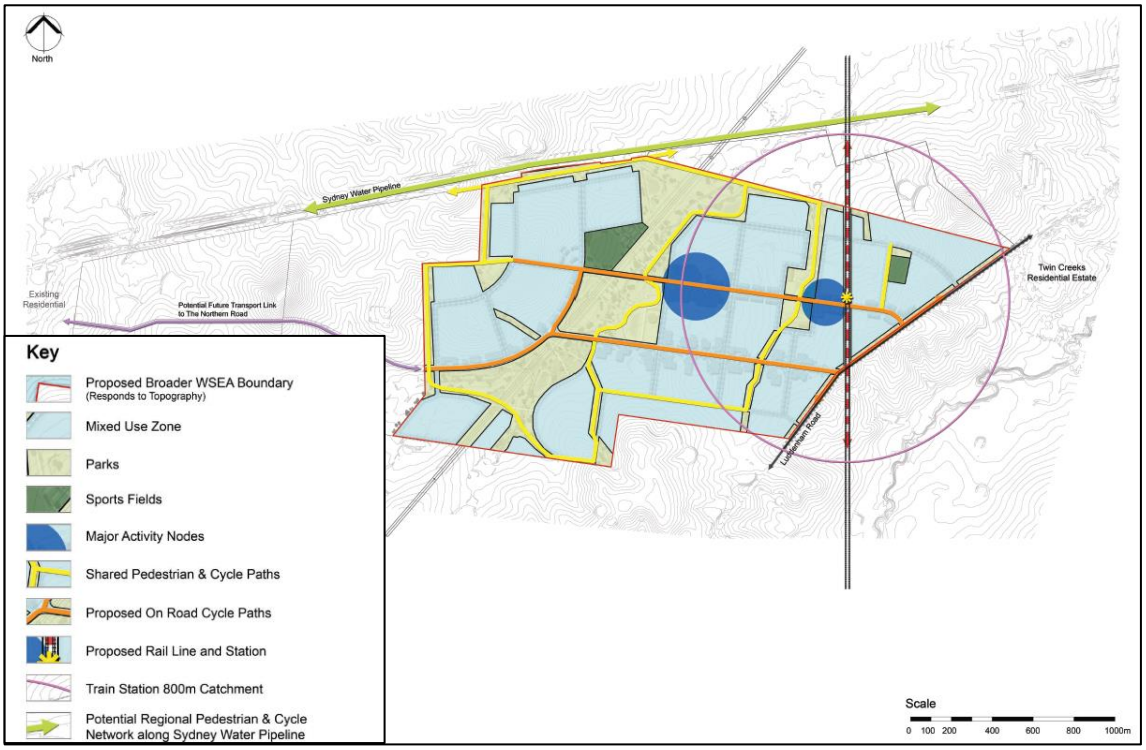
Through the delivery of a connected network of streets that are easy to navigate will promote walkability. Linear parkways and riparian corridors will provide for major pedestrian and cycle network, with City Road and Commercial Road forming the major cycle commuter routes with on-street bike paths.

City Road will be seen as the major pedestrian connector to the site of the potential future railway station, with wide walkways and activated frontages.

There is also a potential to explore using the Sydney Water pipeline as a regional pedestrian and cycle network corridor.

The proposed network of pedestrian and cycle facilities is shown in Figure 3.5.

Figure 3.5: Proposed Pedestrian and Cycle Network



Source: DesignIQ for EJC.

4. Transport and Traffic Impacts

4.1 Overview of Traffic Assessment Methodology

As noted above the Sydney Science Park site is located in the BWSEA. As such the BWSEA Structure Plan has envisaged that development on the Sydney Science Park site would occur as part of the broader area redevelopment and has planned for the associated transport infrastructure.

However development of the BWSEA and associated transport infrastructure is expected to occur over the next 30 years. The staging of development is not yet known and will depend on a number of factors.

The development of the Sydney Science Park site is likely to be ahead of expected development in the north western corner of the BWSEA. As such development of the Sydney Science Park has the potential to generate transport demands for infrastructure in this area earlier than expected under the BWSEA Structure Plan.

In order to assess the traffic and transport implications of the staged development of both the Sydney Science Park and the BWSEA a two stage approach was undertaken.

The staged methodology employed was to:

- Early Development (2021) – determine what level of development could be accommodated on the Sydney Science Park site with the existing transport infrastructure stage.
- Ultimate development (2036) – determine what transport infrastructure (if any) over and above that envisaged for the BWSEA would be required to accommodate the ultimate development of the Sydney Science Park site.

To assist with the assessment of the ultimate development, GHD were engaged to undertake traffic modelling using the traffic model they have developed with the Department of Planning and Infrastructure for the BWSEA Structure Plan.

4.2 Traffic Modelling Assumptions

4.2.1 Traffic Generation Rates

Traffic generation estimates for the proposed development have been based on the following assumptions:

Employment

The following assumptions were made for the employment / commercial component of the site:

- employment density of 34.7 square metres per employee
- PM peak traffic generation corresponding to rate in *RTA Guide to Traffic Generating Developments* (RMS, 2002) of 2.0 car trips per 4.75 employees, or equivalent to 0.421 trips per employee.

Education

Based on a review of the Werrington Enterprise Living and Learning (WELL) precinct Transport Management and Accessibility Plan (TMAP)[6], in particular the generation rates used for the UWS education precinct, the following assumptions were made for the education component of the site:

- student density of 10 square metres per student
- AM peak traffic generations rate = 0.10 trip per student
- PM peak traffic generations rate = 0.07 trip per student.

Retail

Peak period retail traffic was assumed to be generated internally only, i.e. by other Sydney Science Park land uses. Therefore, no external peak period retail traffic was included in the traffic generation.

Detached Dwellings

The traffic generation rates for detached dwellings were estimated based on the Sydney average trip rate for low-density residential development as given in RMS Technical Direction TD13/04a, as follows:

- AM peak traffic generation rate = 0.95 trip per dwelling
- PM peak traffic generation rate = 0.99 trip per dwelling.

Terrace, townhouses and apartment dwellings

The traffic generation rates for terrace, townhouses and apartment housing were estimated based on the Sydney average trip rate for medium-density residential development as gathered by GTA Consultants under a separate engagement with the RMS, as follows:

- AM peak traffic generation rate = 0.40 trip per dwelling
- PM peak traffic generation rate = 0.48 trip per dwelling.

Student Accommodation

No external peak traffic generation was assumed for student accommodation.

4.2.2 Public Transport Mode Shift

A progressively increasing mode shift has been assumed, from 2 per cent in 2016 increasing by 2 per cent every five years as follows:

- 4 per cent in 2021
- 6 per cent in 2026
- 8 per cent in 2031
- 10 per cent in 2036
- 12 per cent in 2041.

These could be considered conservative in view of the targets set out in the NSW Long Term Transport Master Plan.

[6] Section 6.2.4 of the WELL TMAP report, http://www.penrithcity.nsw.gov.au/uploadedFiles/Website/Your_Council/WELL/TMAP/TravelDemand.pdf

4.2.3 Trip Containment

The Planning Proposal entails a mix of uses that would serve to contain a portion trips to within the boundaries of the site, reducing the external traffic generation. The level of trip containment was assumed to progressively increase as development takes shape, as follows:

- Zero per cent prior to 2026
- 5 per cent by 2026
- 10 per cent by 2031
- 15 per cent by 2036
- 20 per cent by 2041.

4.2.4 Directional Split

To account for peak traffic directional flows, the following assumptions were made for traffic generated by the various components of the proposed development:

AM peak

- Employment and education: 80 per cent inbound and 20 per cent outbound
- Residential uses: 20 per cent inbound and 80 per cent outbound.

PM peak

- Employment and education: 20 per cent inbound and 80 per cent outbound
- Residential uses: 80 per cent inbound and 20 per cent outbound.

Note that the retail uses and student dwellings were assumed not to generate any external traffic during the peak periods.

4.2.5 Traffic Generation Summary

Applying the traffic generation rates, the public transport mode shift, trip containment and directional split assumptions discussed in the preceding sections to the estimated development yield for the site results in the aggregated traffic generation for the site shown in Table 4.1 for the AM peak and Table 4.2 for the PM peak.

Table 4.1: AM Peak Traffic Generation Summary

Use	Peak Period Traffic Generation (car trips)					
	2016	2021	2026	2031	2036	2041
Employment	121	607	1,456	2,305	3,519	4,126
Education		100	300	600	800	1,000
Local Retail		-	-	-	-	-
Detached housing		48	143	214	285	285
Terrace housing/townhouse		20	120	340	480	480
Apartments		20	180	230	350	600
Student accommodation		-	-	-	-	-
Sub-total	121	794	2,199	3,689	5,434	6,491
Mode shift	2%	4%	6%	8%	10%	12%
Trips after mode shift discount	119	762	2,067	3,394	4,890	5,712
Trip containment	0%	0%	5%	10%	15%	20%
Total external traffic generation	**119**	**762**	**1,963**	**3,055**	**4,157**	**4,569**

Table 4.2: PM Peak Traffic Generation Summary

Use	Peak Period Traffic Generation (car trips)					
	2016	2021	2026	2031	2036	2041
Employment	121	607	1,456	2,305	3,519	4,126
Education		70	210	420	560	700
Local Retail		-	-	-	-	-
Detached housing		50	149	223	297	297
Terrace housing/townhouse		24	144	408	576	576
Apartments		24	216	276	420	720
Student accommodation		-	-	-	-	-
Sub-total	121	774	2,175	3,632	5,372	6,419
Mode shift	2%	4%	6%	8%	10%	12%
Trips after mode shift discount	119	743	2,044	3,342	4,835	5,648
Trip containment	0%	0%	5%	10%	15%	20%
Total external traffic generation	**119**	**743**	**1,942**	**3,007**	**4,109**	**4,519**

Table 4.1 and Table 4.2 indicate that the likely traffic generation of the site would increase to about 120 trips in the peak periods in the Year 2016, to as high as approximately 4,160 external trips during the Year 2036 AM peak and approximately 50 trips lower during the PM peak.

The level of traffic the site is likely to generate in the year 2016 is within thresholds that could be accommodated by existing road network infrastructure. No additional road works would be required to accommodate the Year 2016 Sydney Science Park traffic generation.

4.3 Year 2021 Future Traffic Conditions

4.3.1 Traffic Distribution and Assignment

The directional distribution and assignment of traffic generated by the proposed development will be influenced by a number of factors, including the:

i configuration of the major road network in the immediate vicinity of the site, including Mamre Road, the M4 Western Motorway, the Westlink M7 Motorway and The Northern Road
ii distribution of residential development in the surrounding areas
iii likely distribution of students' and employees' residences in the Western Sydney region in relation to the site
iv configuration of access points to the site.

Having consideration to the above, for the purposes of estimating vehicle movements, the following directional distributions have been assumed for the short- to medium-term stages of the proposed development (Year 2021):

- to/from Luddenham Road north (towards Mamre Road) = 50 per cent
- to/from Luddenham Road south (towards Elizabeth Drive) = 50 per cent.

These were further split at the Mamre Road and the Elizabeth Drive intersections as follows:

- Mamre Road north (to/from the general direction of the M4 motorway) = 25 per cent
- Mamre Road south (to/from Erskine Park Link Road and Lenore Drive) = 25 per cent
- Elizabeth Drive east (to/from Fairfield and Liverpool) = 25 per cent
- Elizabeth Drive west (to/from The Northern Road and Bringelly) = 25 per cent.

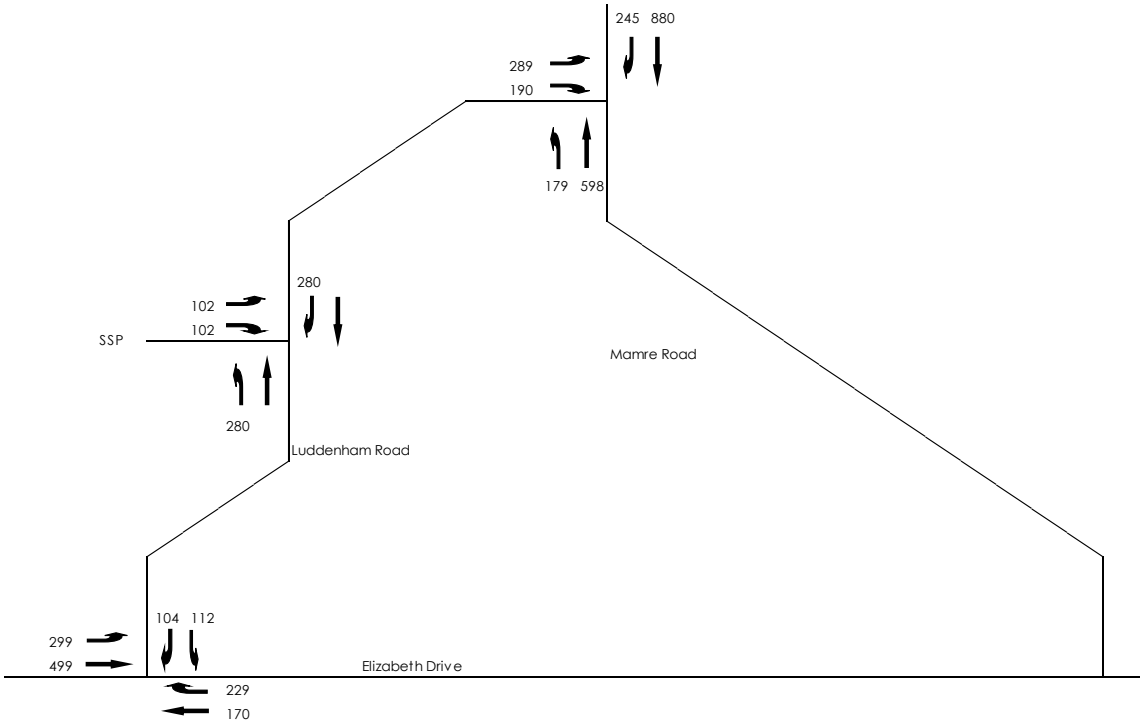
4.3.2 Traffic Growth Rates

A review of historical traffic growth rates in the surrounding areas indicate that traffic volumes on Luddenham Road have been static if not decreasing over time.

In this regard, an average annual traffic growth rate of 1.5 per cent to the year 2021 was assumed and applied to background traffic growth on Luddenham Road, Mamre Road and Elizabeth Drive to determine the potential impacts of traffic generated by the Sydney Science Park.

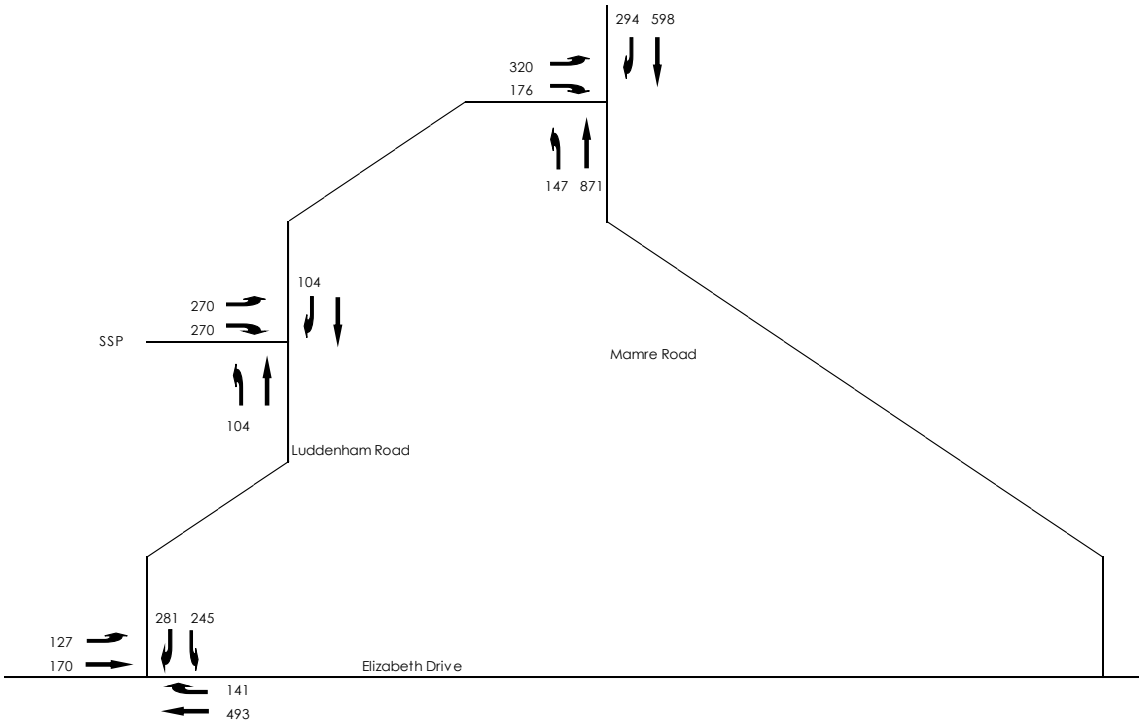
Figure 4.1 and Figure 4.2 have been prepared to show the likely increase in turning movements in the vicinity of the site following development to the Year 2021, with the total traffic generation at that time as shown in Table 4.1 and Table 4.2. The values shown for the year 2021 indicate the likely volumes at the access intersections prior to any major transport network development being implemented as part of the Draft Broader Western Sydney Structure Plan[7].

Figure 4.1: Year 2021 AM Peak Hour Traffic Flows



[7] Draft Broader Western Sydney Employment Area Structure Plan - https://majorprojects.affinitylive.com/public/51487506aef7fad19e6b1e1f1fd1f92a/Draft%20Structure%20Plan.pdf

Figure 4.2: Year 2021 PM Peak Hour Traffic Flows



4.3.3 Traffic Impacts

The key traffic impacts arising from the Planning Proposal up to the year 2021 are primarily focused on the Luddenham Road/Mamre Road and the Luddenham Road/Elizabeth Drive intersections.

For purposes of calculating future background traffic, an average annual growth rate of 1.5 per cent per annum has been assumed on background traffic flows. This assumption could be considered a conservative estimate, as traffic along Luddenham Road has reduced from 2005 volumes. The assumption is consistent with forecast traffic growth rates in the region.

The performance of the Luddenham Road/Mamre Road and the Luddenham Road/Elizabeth Drive intersections with the year 2021 background traffic and Sydney Science Park traffic generation is summarised in Table 4.3.

Table 4.3: 2021 Operating Conditions

Intersection	Peak	Leg	Degree of Saturation (DOS)	Average Delay (sec)	95th Percentile Queue (m)	Level of Service (LOS)
Luddenham Road/ Mamre Road (Luddenham Road with left turn merge lane)	AM	South	0.35	3	0	A
		North	0.50	4	14	A
		West	0.56	22	20	B
	PM	South	0.49	2	0	A
		North	0.58	8	26	A
		West	0.82	30	36	C
Luddenham Road/ Elizabeth Drive	AM	East	0.58	14	3	A
		North	0.36	21	10	B
		West	0.29	4	0	A
	PM	East	0.28	3	6	A
		North	0.75	22	38	B
		West	0.10	5	0	A

Against traffic volumes in the vicinity of the site in 2021, the additional traffic generated by the Sydney Science Park development could not be expected to compromise the safety or function of the surrounding road network.

4.4 Year 2036 Future Conditions

4.4.1 Network Assumptions

The Sydney Science Park traffic modelling for the year 2036 has been undertaken by GHD using the Broader Western Sydney Employment Area (BWSEA) mesoscopic traffic model. This model contains traffic forecasts for the Broader Western Sydney Employment area land release, corresponding to a release of some 2,500 hectares of employment land by 2046.

GHD modelled Sydney Science Park using version 2 of the BWSEA mesoscopic model, which includes revised traffic generation assumptions for the Southern Link Road Precinct. The following input data has been used to model the Sydney Science Park Development:

- Traffic generation forecasts and directional split for morning and evening peak under the 2036 horizon year as shown in Table 4.1 and Table 4.2.
- Proposed development accesses (two signalised and two left-in left-out) on Luddenham Road as discussed in Section 5.1.
- Notional intersection layouts and signal arrangement as developed by GHD.

The peak hour traffic generation shown in Table 4.1 and Table 4.2 were factored up to 4-hourly traffic generation and input to the Aimsun model. These demands were assigned on the morning and evening peak traffic models using Dynamic User Equilibrium assignment, in keeping with the current BWSEA traffic modelling methodology.

4.4.2 Modelled Flows and Network Performance

A summary of modelled peak hour flows from the BWSEA model in the vicinity of Sydney Science Park is shown in Figure 4.3 and Figure 4.4 for the AM and PM peak flows, respectively.

It is noted that for the morning peak scenario, inbound traffic flows did not meet the forecast demands. This indicates that traffic demand through the network in the peak hour exceeded

road network capacity. This is generally for longer distance trips that are affected by congestion in the network that is far removed from the Sydney Science Park Study area and is not a direct consequence of the addition traffic generated by Sydney Science Park. Further refinement of the model is being undertaken to resolve these broader congestion issues.

Figure 4.3: Year 2036 AM Peak Flows

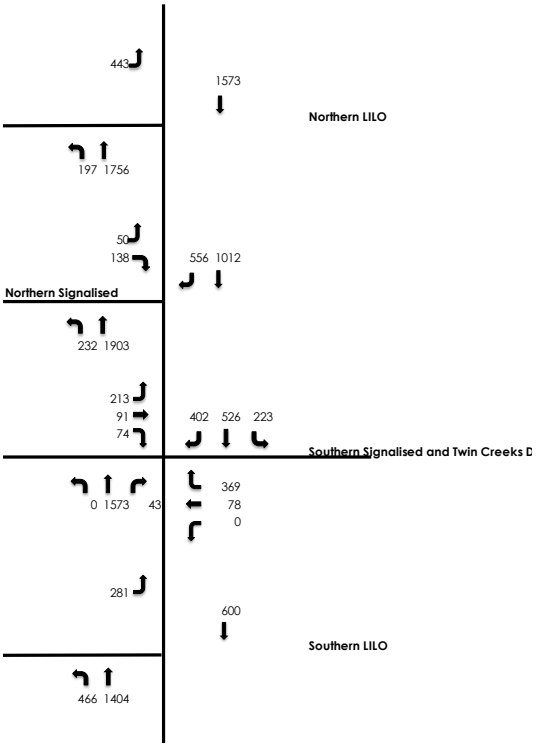
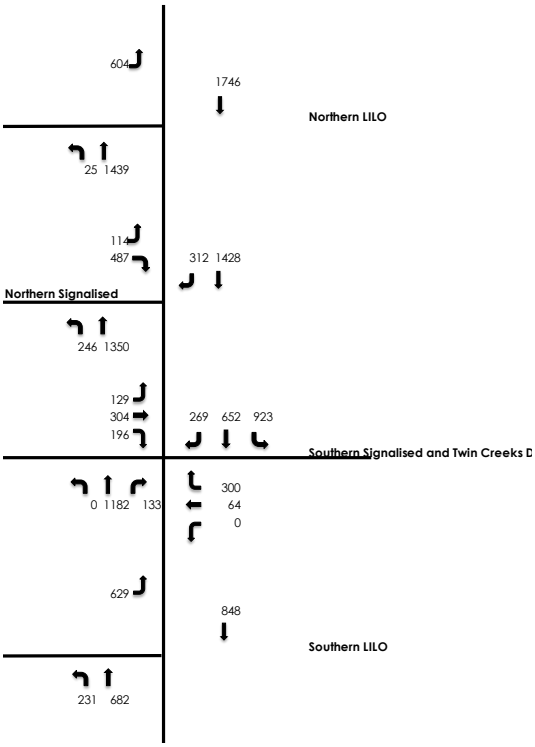


Figure 4.4: Year 2036 PM Peak Flows



Source: GHD

4.4.3 Traffic Impacts

Analysis of traffic flows and traffic density in the vicinity of Sydney Science Park showed that the following roads were likely to experience increases in traffic and congestion:

- Luddenham Road between Elizabeth Drive and Mamre Road
- Mamre Road between Luddenham Road and the M4 Western Motorway
- Proposed extension of Bakers Lane through to Luddenham Road (through Twin Creeks).

The traffic modelling has identified a number of road network improvements to accommodate the Sydney Science Park Planning Proposal and a number of works that will need to be brought forward should development of the Science Park occur in the proposed staging arrangements. These works are identified in the following section of this report.

5. Transport Infrastructure Requirements and Delivery Timing

5.1 Vehicle Access

Vehicle access to the Sydney Science Park site would be principally from Luddenham Road. In order to distribute generated traffic and manage potential traffic queues, a total of four (4) access locations are envisioned by full development of the SSP site. These should be spaced approximately 300 metres apart from each other, linking with east-west roads within the site, as shown in the Master Plan (Figure 3.1).

A potential future link could be provided to The Northern Road to the west, via the existing Gates Road.

In view of the potential traffic impacts, the four vehicle access nodes have been modelled as follows:

- Northern left-in/left-out (LILO) intersection
- Northern signalised T-intersection
- Southern signalised intersection
- Southern left-in/left-out (LILO) intersection

These intersections would need to be constructed to accommodate full development of the Sydney Science Park.

5.2 Year 2021 Road Network Improvements

The following road network improvements are required to accommodate the 2021 development scenario:

Site Vehicular Accesses (Luddenham Road)

- 1 Signalised intersection (City Road)
- 2 left-in/left-out intersections

Luddenham Road/Mamre Road Intersection

- Additional slip lane on the eastbound direction of Luddenham Road approaching Mamre Road to allow for approximately a 40-metre long separate right turn lane.
- A merging lane north of the intersection to allow left turning traffic from Luddenham Road to safely merge with through northbound traffic on Mamre Road.

Luddenham Road/Elizabeth Drive Intersection

- The improvement works required at the Luddenham Road/Elizabeth Drive intersection to mitigate traffic impacts in the year 2021 would primarily consist of a more legible delineation of the existing southbound approach to the intersection to accommodate separate left turn and right turn lanes.
- No other works needed to accommodate 2021 traffic.

5.3 Year 2036 Road Network Improvements

The following road network improvements are required to accommodate the 2036 development scenario. Note the item numbers are referenced in Figure 5.1.

Site Vehicular Accesses (Luddenham Road)

- 2 Signalised intersections
- 2 left-in/left-out intersections

Item 1 - Luddenham Road Widening

- Widening of Luddenham Road between proposed new road north of Elizabeth Drive and the Sydney Catchment Authority pipeline.

Item 2 - Luddenham Road / Mamre Road Intersection

- Luddenham Road/Mamre Road intersection upgraded from priority to traffic signals, with the left turn from Luddenham Road to Mamre Road widened to two lanes.

Item 3 & 5 - Bakers Lane

- Proposed extension of Bakers Lane between Mamre Road and Luddenham Road was notionally combined with an access to Sydney Science Park in a signalised four-way intersection.

Item 4 - Mamre Road Widening

- Widening of Mamre Road to two lanes in each direction between Bakers Lane and Luddenham Road and Mamre Road.

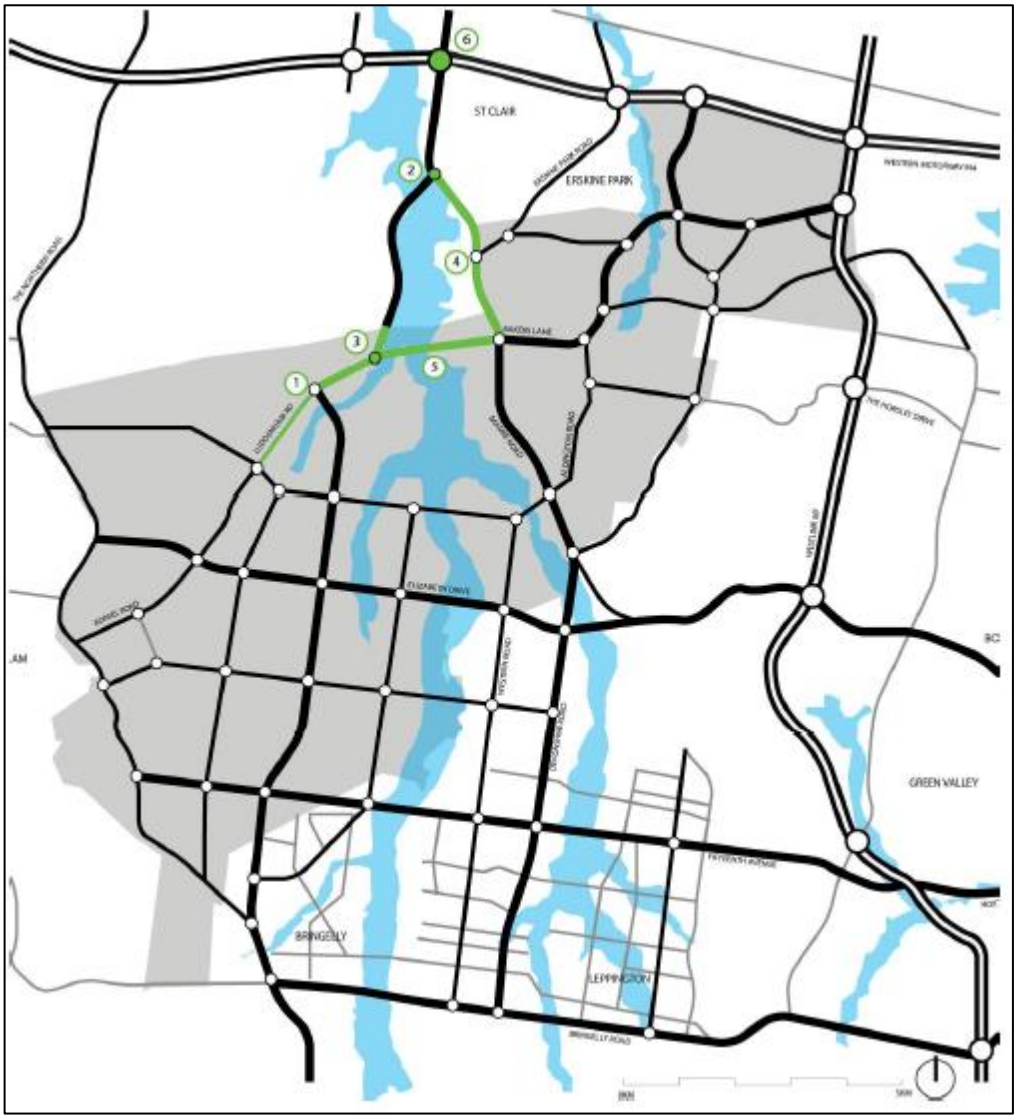
Item 6 – Mamre Road / M4 Motorway

- Upgrade of the Mamre Road interchange at the M4 Western Motorway to allow for additional off-ramp capacity and six lanes over the M4 Motorway.

It is likely that the development of Sydney Science Park will accelerate the need for these already identified network upgrades. However this would need to be determined through modelling of the forecast 2026 interim year, which was not undertaken as a part of this exercise.

A summary of the location of the above works is provided in Figure 5.1.

Figure 5.1: Summary of Proposed Road Projects



Source: GHD (December 2013)

5.4 Public Transport

Given that there is currently no public transport service available for the Sydney Science Park site, at least one bus route to serve Sydney Science Park would be required as part of the development, as well as to contribute towards attaining public transport mode shift targets. This bus route could either be:

- a new bus route linking with either St Marys or Penrith Transport Interchange, or
- extension/rerouting of bus route 779 when Bakers Lane extension is built.

The frequency of the bus route could initially follow the current frequency of route 779, potentially increasing to more frequent services, or expanding route coverage as development occurs into the future.

Internally, the bus route within the Sydney Science Park is proposed to follow the alignment shown in Figure 3.4.

The Planning Proposal incorporates the provision of a corridor and spatial allocation for a potential future passenger railway station should such railway line be available in the future.

5.5 Funding Arrangements for Infrastructure Improvements

As the Sydney Science Park site is located within the BWSEA it is expected that development of the Sydney Science Park project will be required to contribute to the provision of transport infrastructure within the BWSEA.

It is suggested that the appropriate mechanism for contributions to works be through State Infrastructure Contributions (SIC) funds for works on roads and corridors which attract SIC funds or alternatively through works in kind.

The development of the Sydney Science Park project as proposed has the potential to bring forward a range of works, thus providing benefits to the Sydney Science Park and the north western corner of the BWSEA more generally.

It is recommended that payment of SIC levies, or alternatively, provision of Works-in-Kind be linked with the staged development of the Sydney Science Park site. That is, payment of SIC for the road works be on a "pay-as-you-go" basis, as the detailed timing of development for the Sydney Science Park and surrounding sites is not precisely known at this stage.

Notwithstanding the above, there are a number of site enabling works, namely site intersections along Luddenham Road that, are considered the responsibility of the development.

6. Conclusions

This report has presented the findings of transport and access impact assessment associated with the Sydney Science Park Planning Proposal at Luddenham.

The Sydney Science Park site is located within the Broader Western Sydney Employment Area (BWSEA). The State Government's vision for the BWSEA is "to provide well located, services employment lands to secure the State's future productivity and economic growth".

The Sydney Science Park Planning proposal presents a unique vision for the development of the site but is entirely consistent with the State Government's vision for Western Sydney employment as set out in the BWSEA.

Through its consolidated land holdings, the Sydney Science Park planning proposal represents an opportunity to bring forward key infrastructure delivery and potential to accelerate the development of land in the north western corner of the BWSEA.

This report has provided an assessment of the anticipated transport implications of the Sydney Science Park Planning Proposal, for both the short term (2021) and longer term (2036) development of the site in the context of development in the broader regional area (i.e. BWSEA). The assessment considered:

- Capacity of the existing transport network to accommodate short term (2021) development yields on the Sydney Science Park Site.
- Capacity of the future transport network as envisaged by the BWSEA Structure Plan to accommodate the ultimate development proposal of the Sydney Science Park planning proposal.

The infrastructure improvements to accommodate the short term (2021) and long term development both internally and external to the site have been identified.

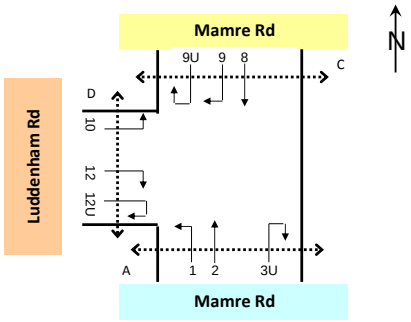
In summary, the package of transport improvement works identified in this assessment when combined with the identified transport improvement works envisaged in the Draft BWSEA Structure Plan will satisfactorily accommodate the future transport demands of the Sydney Science Park planning proposal development.

Appendix A

Survey Results

Job No. : N1227
Client : GTA
Suburb : Orchard Hills
Location : 1. Luddenham Rd / Mamre Rd

Day/Date : Tue, 22nd October 2013
Weather : Fine
Description : Classified Intersection Count
: Peak Hour Summary



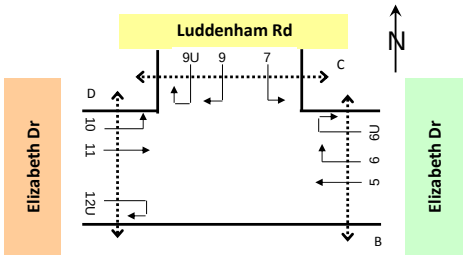
SKYHIGH - THE TRAFFIC SURVEY COMPANY

	Approach	Mamre Rd						Mamre Rd					Luddenham Rd					Grand Total
	Time Period	Cars	Trucks	Buses	Cyclists	Total		Cars	Trucks	Buses	Cyclists	Total	Cars	Trucks	Buses	Cyclists	Total	
AM	7:45 to 8:45	544	65	8	0	**617**		728	87	9	0	**824**	312	25	0	0	**337**	**1,778**
PM	16:30 to 17:30	800	55	2	0	**857**		674	70	2	0	**746**	178	21	1	0	**200**	**1,803**

Approach	Mamre Rd						Mamre Rd					Luddenham Rd					Grand Total
Time Period	Cars	Trucks	Buses	Cyclists	Total		Cars	Trucks	Buses	Cyclists	Total	Cars	Trucks	Buses	Cyclists	Total	
6:00 to 7:00	375	75	2	0	**452**		591	90	2	0	**683**	183	45	0	0	**228**	**1,363**
6:15 to 7:15	387	77	2	0	**466**		600	105	1	0	**706**	204	42	0	0	**246**	**1,418**
6:30 to 7:30	394	62	1	0	**457**		614	100	3	0	**717**	232	41	0	0	**273**	**1,447**
6:45 to 7:45	360	54	2	0	**416**		649	98	3	1	**751**	250	36	0	0	**286**	**1,453**
7:00 to 8:00	388	50	1	0	**439**		703	76	6	1	**786**	267	34	0	0	**301**	**1,526**
7:15 to 8:15	428	55	2	0	**485**		772	76	8	1	**857**	277	33	0	0	**310**	**1,652**
7:30 to 8:30	500	60	6	0	**566**		781	82	10	1	**874**	306	28	0	0	**334**	**1,774**
7:45 to 8:45	544	65	8	0	**617**		728	87	9	0	**824**	312	25	0	0	**337**	**1,778**
8:00 to 9:00	573	61	9	0	**643**		650	92	6	0	**748**	284	20	0	0	**304**	**1,695**
AM Totals	**1,336**	**186**	**12**	**0**	**1,534**		**1,944**	**258**	**14**	**1**	**2,217**	**734**	**99**	**0**	**0**	**833**	**4,584**
15:00 to 16:00	660	82	8	0	**750**		561	101	6	1	**669**	155	26	0	0	**181**	**1,600**
15:15 to 16:15	710	86	6	0	**802**		565	102	7	0	**674**	151	23	0	0	**174**	**1,650**
15:30 to 16:30	717	70	6	1	**794**		606	92	3	0	**701**	146	17	1	0	**164**	**1,659**
15:45 to 16:45	717	66	3	1	**787**		667	86	2	0	**755**	141	19	2	0	**162**	**1,704**
16:00 to 17:00	741	55	2	1	**799**		686	88	2	0	**776**	161	21	2	0	**184**	**1,759**
16:15 to 17:15	775	46	2	1	**824**		671	79	2	0	**752**	168	21	2	0	**191**	**1,767**
16:30 to 17:30	800	55	2	0	**857**		674	70	2	0	**746**	178	21	1	0	**200**	**1,803**
16:45 to 17:45	792	49	2	0	**843**		674	57	1	0	**732**	178	16	0	0	**194**	**1,769**
17:00 to 18:00	767	48	1	0	**816**		669	52	1	0	**722**	168	10	0	0	**178**	**1,716**
PM Totals	**2,168**	**185**	**11**	**1**	**2,365**		**1,916**	**241**	**9**	**1**	**2,167**	**371**	**39**	**2**	**0**	**412**	**4,944**

Job No. : N1227
Client : GTA
Suburb : Orchard Hills
Location : 2. Luddenham Rd / Elizabeth Dr

Day/Date : Tue, 22nd October 2013
Weather : Fine
Description : Classified Intersection Count
: Peak Hour Summary



SKYHIGH - THE TRAFFIC SURVEY COMPANY

	Approach		Elizabeth Dr					Luddenham Rd					Elizabeth Dr					Grand Total
	Time Period		Cars	Trucks	Buses	Cyclists	Total	Cars	Trucks	Buses	Cyclists	Total	Cars	Trucks	Buses	Cyclists	Total	
AM	7:15	to 8:15	191	35	0	0	**226**	92	9	1	0	**102**	583	51	1	0	**635**	**963**
PM	16:15	to 17:15	469	46	1	0	**516**	224	22	0	0	**246**	197	32	0	0	**229**	**991**

Approach		Elizabeth Dr					Luddenham Rd					Elizabeth Dr					Grand Total
Time Period		Cars	Trucks	Buses	Cyclists	Total	Cars	Trucks	Buses	Cyclists	Total	Cars	Trucks	Buses	Cyclists	Total	
6:00	to 7:00	166	44	2	0	**212**	94	16	0	0	**110**	412	115	0	0	**527**	**849**
6:15	to 7:15	177	52	1	0	**230**	90	15	0	0	**105**	452	111	0	0	**563**	**898**
6:30	to 7:30	183	44	1	0	**228**	86	13	1	0	**100**	490	95	0	0	**585**	**913**
6:45	to 7:45	178	42	0	0	**220**	71	8	1	0	**80**	568	81	0	0	**649**	**949**
7:00	to 8:00	183	36	0	0	**219**	73	9	1	0	**83**	584	61	1	0	**646**	**948**
7:15	to 8:15	191	35	0	0	**226**	92	9	1	0	**102**	583	51	1	0	**635**	**963**
7:30	to 8:30	196	34	0	0	**230**	93	8	0	0	**101**	531	52	1	0	**584**	**915**
7:45	to 8:45	221	32	0	0	**253**	99	11	0	0	**110**	445	46	1	0	**492**	**855**
8:00	to 9:00	218	37	0	0	**255**	89	13	0	1	**103**	398	50	0	0	**448**	**806**
AM Totals		**567**	**117**	**2**	**0**	**686**	**256**	**38**	**1**	**1**	**296**	**1,394**	**226**	**1**	**0**	**1,621**	**2,603**
15:00	to 16:00	318	70	2	0	**390**	163	30	0	0	**193**	196	35	0	0	**231**	**814**
15:15	to 16:15	353	80	3	0	**436**	184	29	0	0	**213**	205	39	0	0	**244**	**893**
15:30	to 16:30	391	73	3	0	**467**	205	28	0	0	**233**	207	44	0	0	**251**	**951**
15:45	to 16:45	409	63	4	0	**476**	222	24	0	0	**246**	201	43	0	0	**244**	**966**
16:00	to 17:00	443	60	3	0	**506**	218	24	0	0	**242**	197	37	0	0	**234**	**982**
16:15	to 17:15	469	46	1	0	**516**	224	22	0	0	**246**	197	32	0	0	**229**	**991**
16:30	to 17:30	468	48	1	0	**517**	208	20	0	0	**228**	197	21	0	0	**218**	**963**
16:45	to 17:45	473	44	0	0	**517**	209	16	0	0	**225**	207	18	0	0	**225**	**967**
17:00	to 18:00	454	31	0	0	**485**	208	21	0	0	**229**	188	20	0	0	**208**	**922**
PM Totals		**1,215**	**161**	**5**	**0**	**1,381**	**589**	**75**	**0**	**0**	**664**	**581**	**92**	**0**	**0**	**673**	**2,718**

Job No	N1227
Client	GTA
Road	Luddenham Rd - at Sydney Water Pipeline
Location	Luddenham
Site No.	1
Start Date	22-Oct-13
Description	Volume Summary
Direction	Combined

Average Weekday	5,003
7 Day Average	4,798

Time	Day of Week							Ave W'day	7 Day Ave
	Mon	Tue	Wed	Thu	Fri	Sat	Sun		
	28-Oct	22-Oct	23-Oct	24-Oct	25-Oct	26-Oct	27-Oct		
AM Peak	365	395	412	417	380	304	301		
PM Peak	478	463	464	448	457	386	322		
0:00	12	22	22	22	26	47	78	21	33
1:00	14	15	16	14	10	34	37	14	20
2:00	12	4	13	15	17	14	15	12	13
3:00	15	20	19	20	17	18	16	18	18
4:00	61	53	49	51	57	26	20	54	45
5:00	222	226	237	233	214	73	37	226	177
6:00	352	364	378	348	352	166	81	359	292
7:00	365	380	412	383	380	219	119	384	323
8:00	361	395	364	417	336	229	196	375	328
9:00	223	243	287	220	243	259	231	243	244
10:00	202	204	197	214	232	286	281	210	231
11:00	174	191	195	203	207	304	301	194	225
12:00	191	214	244	207	211	385	313	213	252
13:00	206	212	184	246	233	386	295	216	252
14:00	245	270	285	279	299	358	288	276	289
15:00	407	407	373	440	426	331	322	411	387
16:00	389	417	438	424	457	329	305	425	394
17:00	478	463	464	448	445	347	268	460	416
18:00	309	313	294	337	403	283	208	331	307
19:00	193	189	173	202	226	167	137	197	184
20:00	122	132	121	154	145	123	100	135	128
21:00	78	105	120	118	135	138	73	111	110
22:00	67	67	63	72	80	143	55	70	78
23:00	31	40	55	35	83	100	26	49	53
Total	4729	4948	5003	5102	5234	4765	3802	5003	4798

7-19	3550	3709	3737	3818	3872	3716	3127	3737	3647
6-22	4295	4500	4529	4640	4730	4310	3518	4539	4360
6-24	4393	4608	4647	4747	4893	4553	3599	4658	4491
0-24	4729	4948	5003	5102	5234	4765	3802	5003	4798

Job No	N1227
Client	GTA
Road	Elizabeth Drv - btw Luddenham Rd and Badgery's
Location	Luddenham
Site No.	3
Start Date	22-Oct-13
Description	Volume Summary
Direction	Combined

Average Weekday	7,952
7 Day Average	7,203

Time	Day of Week							Ave W'day	7 Day Ave
	Mon	Tue	Wed	Thu	Fri	Sat	Sun		
	28-Oct	22-Oct	23-Oct	24-Oct	25-Oct	26-Oct	27-Oct		
AM Peak	774	800	741	759	831	422	414		
PM Peak	673	746	679	734	708	435	420		
0:00	15	27	15	22	28	83	85	21	39
1:00	21	18	16	19	26	40	45	20	26
2:00	19	28	22	23	30	29	23	24	25
3:00	41	40	44	38	39	29	16	40	35
4:00	113	117	101	88	112	43	21	106	85
5:00	346	368	394	394	334	144	60	367	291
6:00	686	675	671	696	683	264	113	682	541
7:00	774	800	741	759	831	272	139	781	617
8:00	584	605	605	583	644	285	217	604	503
9:00	361	383	458	377	472	334	325	410	387
10:00	362	359	339	337	344	404	373	348	360
11:00	320	305	363	354	353	422	414	339	362
12:00	330	342	316	370	404	434	420	352	374
13:00	351	381	353	377	420	435	366	376	383
14:00	421	452	458	472	490	379	383	459	436
15:00	559	601	587	541	648	366	356	587	523
16:00	673	746	679	703	697	363	399	700	609
17:00	671	690	638	734	708	396	338	688	596
18:00	399	412	381	420	457	295	274	414	377
19:00	221	220	199	224	289	220	195	231	224
20:00	127	133	143	168	153	154	125	145	143
21:00	86	110	121	130	140	111	114	117	116
22:00	72	65	53	97	139	152	62	85	91
23:00	38	33	50	48	99	107	39	54	59
Total	7590	7910	7747	7974	8540	5761	4902	7952	7203

7-19	5805	6076	5918	6027	6468	4385	4004	6059	5526
6-22	6925	7214	7052	7245	7733	5134	4551	7234	6551
6-24	7035	7312	7155	7390	7971	5393	4652	7373	6701
0-24	7590	7910	7747	7974	8540	5761	4902	7952	7203

Appendix B

SIDRA INTERSECTION Modelling Results

MOVEMENT SUMMARY

Site: Mamre Rd - Luddenham Rd
Ex AM - dummy leg

13S9028000
Mamre Road - Luddenham Road
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mamre Road											
1	L	37	8.6	0.021	11.4	LOS A	0.0	0.0	0.00	0.73	58.9
2	T	559	11.9	0.309	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		596	11.7	0.309	0.7	NA	0.0	0.0	0.00	0.05	78.3
North: Mamre Road											
8	T	822	9.6	0.448	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
9	R	98	18.3	0.124	15.5	LOS B	0.5	4.3	0.59	0.84	54.4
Approach		920	10.5	0.448	1.7	NA	0.5	4.3	0.06	0.09	76.3
North West: Seagull lane											
29	R	129	5.7	0.146	5.7	LOS A	0.4	3.2	0.54	0.72	31.7
Approach		129	5.7	0.146	5.7	LOS A	0.4	3.2	0.54	0.72	31.7
West: Luddenham Road											
10	L	222	10.0	0.659	22.3	LOS B	4.8	36.1	0.77	1.12	46.7
12	R	129	5.7	0.659	22.0	LOS B	4.8	36.1	0.77	1.12	46.8
Approach		352	8.4	0.659	22.2	LOS B	4.8	36.1	0.77	1.12	46.7
All Vehicles		1997	10.2	0.659	5.2	NA	4.8	36.1	0.20	0.30	64.0

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Mamre Rd - Luddenham Rd
Ex PM - dummy leg

13S9028000
Mamre Road - Luddenham Road
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mamre Road											
1	L	88	8.3	0.050	11.4	LOS A	0.0	0.0	0.00	0.73	58.9
2	T	814	6.5	0.435	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		902	6.7	0.435	1.1	NA	0.0	0.0	0.00	0.07	77.3
North: Mamre Road											
8	T	559	10.5	0.306	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
9	R	226	7.4	0.344	17.7	LOS B	1.7	13.0	0.72	0.98	51.1
Approach		785	9.7	0.344	5.1	NA	1.7	13.0	0.21	0.28	68.9
North West: Seagull lane											
29	R	38	22.2	0.040	4.9	LOS A	0.1	1.0	0.43	0.56	32.0
Approach		38	22.2	0.040	4.9	LOS A	0.1	1.0	0.43	0.56	32.0
West: Luddenham Road											
10	L	173	8.5	0.638	29.3	LOS C	3.5	26.9	0.86	1.13	41.1
12	R	38	22.2	0.638	30.1	LOS C	3.5	26.9	0.86	1.11	41.2
Approach		211	11.0	0.638	29.4	LOS C	3.5	26.9	0.86	1.12	41.2
All Vehicles		1936	8.6	0.638	5.9	NA	3.5	26.9	0.19	0.28	66.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Mamre Rd - Luddenham Rd
Base + Dev 2021 AM + slip exit

13S9028000
Mamre Road - Luddenham Road
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mamre Road											
1	L	188	1.7	0.103	11.0	LOS A	0.0	0.0	0.00	0.73	58.9
2	T	629	10.5	0.345	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		818	8.5	0.345	2.5	NA	0.0	0.0	0.00	0.17	74.0
North: Mamre Road											
8	T	926	8.5	0.501	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
9	R	258	6.9	0.354	17.0	LOS B	1.9	13.9	0.69	0.97	51.8
Approach		1184	8.2	0.501	3.7	NA	1.9	13.9	0.15	0.21	71.7
North West: Seagull lane											
29	R	200	3.7	0.487	13.7	LOS A	1.9	13.4	0.87	1.07	28.7
Approach		200	3.7	0.487	13.7	LOS A	1.9	13.4	0.87	1.07	28.7
West: Luddenham Road											
10	L	304	7.3	0.172	11.4	X	X	X	X	0.69	58.8
12	R	200	3.7	0.558	25.6	LOS B	2.8	20.3	0.84	1.07	43.6
Approach		504	5.8	0.558	17.0	LOS B	2.8	20.3	0.33	0.84	51.7
All Vehicles		2706	7.5	0.558	6.6	NA	2.8	20.3	0.19	0.38	61.2

X: Not applicable for Continuous movement.

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Mamre Rd - Luddenham Rd
Base + Dev 2021 PM + slip exit

13S9028000
Mamre Road - Luddenham Road
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mamre Road											
1	L	155	2.0	0.085	11.0	LOS A	0.0	0.0	0.00	0.73	58.9
2	T	917	7.2	0.492	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		1072	6.5	0.492	1.6	NA	0.0	0.0	0.00	0.11	76.1
North: Mamre Road											
8	T	629	12.5	0.349	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
9	R	309	5.8	0.577	22.7	LOS B	3.6	26.1	0.85	1.10	46.1
Approach		939	10.3	0.577	7.5	NA	3.6	26.1	0.28	0.36	64.6
North West: Seagull lane											
29	R	185	4.0	0.472	14.0	LOS A	1.8	12.7	0.87	1.06	28.6
Approach		185	4.0	0.472	14.0	LOS A	1.8	12.7	0.87	1.06	28.6
West: Luddenham Road											
10	L	337	6.6	0.190	11.4	X	X	X	X	0.69	58.8
12	R	185	4.0	0.817	49.4	LOS D	5.0	36.0	0.96	1.27	30.6
Approach		522	5.6	0.817	24.9	LOS B	5.0	36.0	0.34	0.89	44.4
All Vehicles		2718	7.5	0.817	8.9	NA	5.0	36.0	0.22	0.41	58.1

X: Not applicable for Continuous movement.

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Elizabeth Rd - Luddenham Rd Base - Ex AM

13S9028000
Elizabeth Road - Luddenham Road, Luddenham
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South East: Elizabeth Road											
22	T	159	19.9	0.092	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
23	R	83	5.1	0.146	15.8	LOS B	0.5	3.8	0.57	0.89	53.1
Approach		242	14.8	0.146	5.4	NA	0.5	3.8	0.20	0.30	68.3
North East: Luddenham Road											
24	L	57	5.6	0.091	15.0	LOS B	0.3	2.4	0.53	0.83	54.1
26	R	49	10.6	0.119	18.6	LOS B	0.4	3.1	0.66	0.91	50.3
Approach		106	7.9	0.119	16.7	LOS B	0.4	3.1	0.59	0.87	52.2
North West: Elizabeth Road											
27	L	148	5.7	0.083	11.3	LOS A	0.0	0.0	0.00	0.73	58.9
28	T	466	10.2	0.255	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		615	9.1	0.255	2.7	NA	0.0	0.0	0.00	0.18	73.7
All Vehicles		963	10.4	0.255	4.9	NA	0.5	3.8	0.11	0.28	69.2

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Elizabeth Rd - Luddenham Rd Base - Ex PM

13S9028000
Elizabeth Road - Luddenham Road, Luddenham
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South East: Elizabeth Road											
22	T	461	8.7	0.250	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
23	R	83	13.9	0.105	13.6	LOS A	0.4	3.1	0.40	0.74	56.4
Approach		544	9.5	0.250	2.1	NA	0.4	3.1	0.06	0.11	75.3
North East: Luddenham Road											
24	L	103	7.1	0.109	12.5	LOS A	0.4	3.1	0.32	0.70	57.1
26	R	137	10.0	0.301	19.2	LOS B	1.2	9.5	0.68	0.95	49.7
Approach		240	8.8	0.301	16.3	LOS B	1.2	9.5	0.53	0.84	52.6
North West: Elizabeth Road											
27	L	71	3.0	0.039	11.1	LOS A	0.0	0.0	0.00	0.73	58.9
28	T	159	12.6	0.088	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		229	9.6	0.088	3.4	NA	0.0	0.0	0.00	0.22	72.2
All Vehicles		1014	9.3	0.301	5.7	NA	1.2	9.5	0.16	0.31	67.8

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Elizabeth Rd - Luddenham Rd Base + Dev - 2021 AM

13S9028000
Elizabeth Road - Luddenham Road, Luddenham
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South East: Elizabeth Road											
22	T	179	17.6	0.102	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
23	R	241	1.7	0.579	23.7	LOS B	3.2	22.7	0.82	1.08	45.1
Approach		420	8.5	0.579	13.6	NA	3.2	22.7	0.47	0.62	55.6
North East: Luddenham Road											
24	L	118	2.7	0.225	16.7	LOS B	0.8	6.0	0.62	0.90	51.8
26	R	109	4.8	0.363	25.1	LOS B	1.4	10.4	0.82	1.00	44.1
Approach		227	3.7	0.363	20.7	LOS B	1.4	10.4	0.72	0.95	47.8
North West: Elizabeth Road											
27	L	315	2.7	0.173	11.1	LOS A	0.0	0.0	0.00	0.73	58.9
28	T	525	9.0	0.285	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		840	6.6	0.285	4.1	NA	0.0	0.0	0.00	0.27	70.7
All Vehicles		1487	6.7	0.579	9.3	NA	3.2	22.7	0.24	0.47	61.5

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Elizabeth Rd - Luddenham Rd Base + Dev - 2021 PM

13S9028000
Elizabeth Road - Luddenham Road, Luddenham
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South East: Elizabeth Road											
22	T	524	7.6	0.282	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
23	R	148	7.8	0.207	14.4	LOS A	0.8	6.0	0.50	0.82	55.0
Approach		673	7.7	0.282	3.2	NA	0.8	6.0	0.11	0.18	72.8
North East: Luddenham Road											
24	L	258	2.9	0.280	12.7	LOS A	1.2	8.6	0.41	0.74	56.6
26	R	296	4.6	0.747	29.4	LOS C	5.3	38.4	0.89	1.22	40.9
Approach		554	3.8	0.747	21.6	LOS B	5.3	38.4	0.67	1.00	47.0
North West: Elizabeth Road											
27	L	134	1.6	0.073	11.0	LOS A	0.0	0.0	0.00	0.73	58.9
28	T	179	11.2	0.098	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		313	7.1	0.098	4.7	NA	0.0	0.0	0.00	0.31	69.5
All Vehicles		1539	6.2	0.747	10.1	NA	5.3	38.4	0.29	0.50	60.4

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Mamre Rd - Luddenham Rd
Ex AM - dummy leg

13S9028000
Mamre Road - Luddenham Road
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mamre Road											
1	L	37	8.6	0.021	11.4	LOS A	0.0	0.0	0.00	0.73	58.9
2	T	559	11.9	0.309	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		596	11.7	0.309	0.7	NA	0.0	0.0	0.00	0.05	78.3
North: Mamre Road											
8	T	822	9.6	0.448	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
9	R	98	18.3	0.124	15.5	LOS B	0.5	4.3	0.59	0.84	54.4
Approach		920	10.5	0.448	1.7	NA	0.5	4.3	0.06	0.09	76.3
North West: Seagull lane											
29	R	129	5.7	0.146	5.7	LOS A	0.4	3.2	0.54	0.72	31.7
Approach		129	5.7	0.146	5.7	LOS A	0.4	3.2	0.54	0.72	31.7
West: Luddenham Road											
10	L	222	10.0	0.659	22.3	LOS B	4.8	36.1	0.77	1.12	46.7
12	R	129	5.7	0.659	22.0	LOS B	4.8	36.1	0.77	1.12	46.8
Approach		352	8.4	0.659	22.2	LOS B	4.8	36.1	0.77	1.12	46.7
All Vehicles		1997	10.2	0.659	5.2	NA	4.8	36.1	0.20	0.30	64.0

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Mamre Rd - Luddenham Rd
Ex PM - dummy leg

13S9028000
Mamre Road - Luddenham Road
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mamre Road											
1	L	88	8.3	0.050	11.4	LOS A	0.0	0.0	0.00	0.73	58.9
2	T	814	6.5	0.435	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		902	6.7	0.435	1.1	NA	0.0	0.0	0.00	0.07	77.3
North: Mamre Road											
8	T	559	10.5	0.306	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
9	R	226	7.4	0.344	17.7	LOS B	1.7	13.0	0.72	0.98	51.1
Approach		785	9.7	0.344	5.1	NA	1.7	13.0	0.21	0.28	68.9
North West: Seagull lane											
29	R	38	22.2	0.040	4.9	LOS A	0.1	1.0	0.43	0.56	32.0
Approach		38	22.2	0.040	4.9	LOS A	0.1	1.0	0.43	0.56	32.0
West: Luddenham Road											
10	L	173	8.5	0.638	29.3	LOS C	3.5	26.9	0.86	1.13	41.1
12	R	38	22.2	0.638	30.1	LOS C	3.5	26.9	0.86	1.11	41.2
Approach		211	11.0	0.638	29.4	LOS C	3.5	26.9	0.86	1.12	41.2
All Vehicles		1936	8.6	0.638	5.9	NA	3.5	26.9	0.19	0.28	66.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Mamre Rd - Luddenham Rd
Base + Dev 2021 AM + slip exit

13S9028000
Mamre Road - Luddenham Road
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mamre Road											
1	L	188	1.7	0.103	11.0	LOS A	0.0	0.0	0.00	0.73	58.9
2	T	629	10.5	0.345	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		818	8.5	0.345	2.5	NA	0.0	0.0	0.00	0.17	74.0
North: Mamre Road											
8	T	926	8.5	0.501	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
9	R	258	6.9	0.354	17.0	LOS B	1.9	13.9	0.69	0.97	51.8
Approach		1184	8.2	0.501	3.7	NA	1.9	13.9	0.15	0.21	71.7
North West: Seagull lane											
29	R	200	3.7	0.487	13.7	LOS A	1.9	13.4	0.87	1.07	28.7
Approach		200	3.7	0.487	13.7	LOS A	1.9	13.4	0.87	1.07	28.7
West: Luddenham Road											
10	L	304	7.3	0.172	11.4	X	X	X	X	0.69	58.8
12	R	200	3.7	0.558	25.6	LOS B	2.8	20.3	0.84	1.07	43.6
Approach		504	5.8	0.558	17.0	LOS B	2.8	20.3	0.33	0.84	51.7
All Vehicles		2706	7.5	0.558	6.6	NA	2.8	20.3	0.19	0.38	61.2

X: Not applicable for Continuous movement.

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Mamre Rd - Luddenham Rd
Base + Dev 2021 PM + slip exit

13S9028000
Mamre Road - Luddenham Road
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mamre Road											
1	L	155	2.0	0.085	11.0	LOS A	0.0	0.0	0.00	0.73	58.9
2	T	917	7.2	0.492	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		1072	6.5	0.492	1.6	NA	0.0	0.0	0.00	0.11	76.1
North: Mamre Road											
8	T	629	12.5	0.349	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
9	R	309	5.8	0.577	22.7	LOS B	3.6	26.1	0.85	1.10	46.1
Approach		939	10.3	0.577	7.5	NA	3.6	26.1	0.28	0.36	64.6
North West: Seagull lane											
29	R	185	4.0	0.472	14.0	LOS A	1.8	12.7	0.87	1.06	28.6
Approach		185	4.0	0.472	14.0	LOS A	1.8	12.7	0.87	1.06	28.6
West: Luddenham Road											
10	L	337	6.6	0.190	11.4	X	X	X	X	0.69	58.8
12	R	185	4.0	0.817	49.4	LOS D	5.0	36.0	0.96	1.27	30.6
Approach		522	5.6	0.817	24.9	LOS B	5.0	36.0	0.34	0.89	44.4
All Vehicles		2718	7.5	0.817	8.9	NA	5.0	36.0	0.22	0.41	58.1

X: Not applicable for Continuous movement.

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Elizabeth Rd - Luddenham Rd Base - Ex AM

13S9028000
Elizabeth Road - Luddenham Road, Luddenham
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South East: Elizabeth Road											
22	T	159	19.9	0.092	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
23	R	83	5.1	0.146	15.8	LOS B	0.5	3.8	0.57	0.89	53.1
Approach		242	14.8	0.146	5.4	NA	0.5	3.8	0.20	0.30	68.3
North East: Luddenham Road											
24	L	57	5.6	0.091	15.0	LOS B	0.3	2.4	0.53	0.83	54.1
26	R	49	10.6	0.119	18.6	LOS B	0.4	3.1	0.66	0.91	50.3
Approach		106	7.9	0.119	16.7	LOS B	0.4	3.1	0.59	0.87	52.2
North West: Elizabeth Road											
27	L	148	5.7	0.083	11.3	LOS A	0.0	0.0	0.00	0.73	58.9
28	T	466	10.2	0.255	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		615	9.1	0.255	2.7	NA	0.0	0.0	0.00	0.18	73.7
All Vehicles		963	10.4	0.255	4.9	NA	0.5	3.8	0.11	0.28	69.2

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Elizabeth Rd - Luddenham Rd Base - Ex PM

13S9028000
Elizabeth Road - Luddenham Road, Luddenham
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South East: Elizabeth Road											
22	T	461	8.7	0.250	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
23	R	83	13.9	0.105	13.6	LOS A	0.4	3.1	0.40	0.74	56.4
Approach		544	9.5	0.250	2.1	NA	0.4	3.1	0.06	0.11	75.3
North East: Luddenham Road											
24	L	103	7.1	0.109	12.5	LOS A	0.4	3.1	0.32	0.70	57.1
26	R	137	10.0	0.301	19.2	LOS B	1.2	9.5	0.68	0.95	49.7
Approach		240	8.8	0.301	16.3	LOS B	1.2	9.5	0.53	0.84	52.6
North West: Elizabeth Road											
27	L	71	3.0	0.039	11.1	LOS A	0.0	0.0	0.00	0.73	58.9
28	T	159	12.6	0.088	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		229	9.6	0.088	3.4	NA	0.0	0.0	0.00	0.22	72.2
All Vehicles		1014	9.3	0.301	5.7	NA	1.2	9.5	0.16	0.31	67.8

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Elizabeth Rd - Luddenham Rd Base + Dev - 2021 AM

13S9028000
Elizabeth Road - Luddenham Road, Luddenham
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South East: Elizabeth Road											
22	T	179	17.6	0.102	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
23	R	241	1.7	0.579	23.7	LOS B	3.2	22.7	0.82	1.08	45.1
Approach		420	8.5	0.579	13.6	NA	3.2	22.7	0.47	0.62	55.6
North East: Luddenham Road											
24	L	118	2.7	0.225	16.7	LOS B	0.8	6.0	0.62	0.90	51.8
26	R	109	4.8	0.363	25.1	LOS B	1.4	10.4	0.82	1.00	44.1
Approach		227	3.7	0.363	20.7	LOS B	1.4	10.4	0.72	0.95	47.8
North West: Elizabeth Road											
27	L	315	2.7	0.173	11.1	LOS A	0.0	0.0	0.00	0.73	58.9
28	T	525	9.0	0.285	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		840	6.6	0.285	4.1	NA	0.0	0.0	0.00	0.27	70.7
All Vehicles		1487	6.7	0.579	9.3	NA	3.2	22.7	0.24	0.47	61.5

Level of Service (LOS) Method: Delay (RTA NSW).
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SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Elizabeth Rd - Luddenham Rd Base + Dev - 2021 PM

13S9028000
Elizabeth Road - Luddenham Road, Luddenham
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South East: Elizabeth Road											
22	T	524	7.6	0.282	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
23	R	148	7.8	0.207	14.4	LOS A	0.8	6.0	0.50	0.82	55.0
Approach		673	7.7	0.282	3.2	NA	0.8	6.0	0.11	0.18	72.8
North East: Luddenham Road											
24	L	258	2.9	0.280	12.7	LOS A	1.2	8.6	0.41	0.74	56.6
26	R	296	4.6	0.747	29.4	LOS C	5.3	38.4	0.89	1.22	40.9
Approach		554	3.8	0.747	21.6	LOS B	5.3	38.4	0.67	1.00	47.0
North West: Elizabeth Road											
27	L	134	1.6	0.073	11.0	LOS A	0.0	0.0	0.00	0.73	58.9
28	T	179	11.2	0.098	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		313	7.1	0.098	4.7	NA	0.0	0.0	0.00	0.31	69.5
All Vehicles		1539	6.2	0.747	10.1	NA	5.3	38.4	0.29	0.50	60.4

Level of Service (LOS) Method: Delay (RTA NSW).
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SIDRA Standard Delay Model used.

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