4.2 Hills M2 Motorway corridor

4.2.1 Traffic crashes

In the project area, the Hills M2 Motorway has a crash history which is demonstrative of typical motorway conditions where grade separation, median barriers, and other safety treatments are used to minimise conflicting or opposing traffic movements. While the crash severity index is broadly consistent with NSW averages, the frequency per vehicle kilometre travelled for both fatal and injury crashes is significantly lower than average.

Table 4.11 summarises the crash history for this period. Maps of the crash locations can be found in **Appendix A**. In summary, between 1 July 2008 and 30 June 2013 on the Hills M2 Motorway between Windsor Road and Pennant Hills Road:

- A total of 149 crashes occurred, with 0 fatal and 62 injury crashes.
- Over 50 per cent of total crashes involved rear-end collisions.
- Heavy vehicles accounted for around 17 per cent of all vehicles involved in crashes.

Table 4.11 Hills M2 Motorway crash history (1 July 2008 to 30 June 2013)

Section from	Section to	Section length (km)	Crashes			
			Total	Fatal	Injury	Tow-away
Hills M2 Motorway						
Total – Windsor Road to Pennant Hills Road		5.0	149	0	62	87

(Source: AECOM, 2014 based on Roads and Maritime Crash Data, 2013)

Crash severity indices are described in **Section 4.1.1**. As shown in **Table 4.12**, within the project area the crash severity index on the Hills M2 Motorway is 1.21, slightly lower than the average of 1.22 for all crashes reported on public roads in the Sydney Metropolitan Area. This index indicates a slightly lower than average proportion of fatal and injury crashes.

Table 4.12 Hill M2 Motorway crash severity indices (1 July 2008 to 30 June 2013)

Section from	Section to	Crash severity index
Hills M2 Motorway		
Total – Windsor Road to Pennant Hills Road		1.21
New South Wales | Sydney Metropolitan Area Average – All roads		
New South Wales (1 Jan 2008 to 31 Dec 2012)		1.24
Sydney Metropolitan Area (1 Jan 2012 to 31 Dec 2012)		1.22

(Source: AECOM, 2014 based on Roads and Maritime Crash Data & TfNSW Centre for Road Safety Data)

Crash rates per 100 million vehicle kilometres travelled (100MVKT) are described in **Section 4.1.1**. These crash rates are calculated using the volume of traffic and distance travelled along a route, therefore offering a measure of risk per kilometre travelled.

The latest available Roads and Maritime data (for the 12 month period ending December 2013) show average fatality and injury rates in the Sydney Metropolitan Area of 0.2 and 29.4 per 100MVKT respectively.

Table 4-13 shows the average fatality and injury rates on the Hills M2 Motorway are 0.0 and 8.3 per 100MVKT respectively, estimated using 2013 traffic volumes. These rates indicate that the occurrence of both fatal and injury crashes on the Hills M2 Motorway are substantially lower per kilometre travelled than the Sydney Metropolitan Area average, with the motorway transiting large volumes of traffic with relatively few incidents.

Table 4-13 Hills M2 Motorway crash rates per 100MVKT (2013)

Section from	Section to	Section length (km)	2013 ADT (veh)	Crash rate per 100MVKT			
				Total	Fatal	Injury	Tow-away
Hills M2 Motorway							
Total – Windsor Road to Pennant Hills Road		5.0	82,200	19.9	0.0	8.3	11.6
New South Wales | Sydney Metropolitan Area Average							
New South Wales (1 Jan 2013 to 31 Dec 2013)		-	-	-	0.5	28.0	-
Sydney Metropolitan Area (1 Jan 2012 to 31 Dec 2012)		-	-	68.8	0.2	29.4	39.2

(Source: AECOM, 2014 based on Roads and Maritime Crash Data & TfNSW Centre for Road Safety Data)

Table 4-14 provides details of the crash costs for the Hills M2 Motorway. Average crash costs based on crash severity have been calculated using Roads and Maritime' Economic Analysis Manual (Economic Parameters for 2009). The crash costs presented in this report are based on a 'willingness to pay' approach; willingness to pay values for road safety reflect the accumulated value the NSW community is willing to pay or forgo in exchange for a reduction in the probability of crash related injuries and deaths on NSW roads.

Crashes on the Hills M2 Motorway between 1 July 2008 and 30 June 2013 cost an estimated total of $26,129,050, or $5,225,810 per annum. The analysis indicates a crash cost per 100MVKT of $3,483,520, which is over four times lower than the equivalent cost for Pennant Hills Road.

Table 4-14 Hills M2 Motorway crash costs (1 July 2008 to 30 June 2013)

Section from	Section to	Section length (km)	2013 ADT (veh)	Crash cost		
				Total Cost	Average Annual Cost	Cost per 100MVKT
Hills M2 Motorway						
Total – Windsor Road to Pennant Hills Road		5.0	82,200	$26,129,050	$5,225,810	$3,483,520

(Source: AECOM, 2014 based on Roads and Maritime Crash Data and Roads and Maritime Economic Analysis Manual (Economic parameters for 2009))

4.2.2 Travel times and speeds

Surveys of travel time and speed on the Hills M2 Motorway between the Westlink M7 Motorway and Lane Cove Tunnel were undertaken during the peak periods and the results are presented in **Table 4-15**. After the Hills M2 Motorway Upgrade, the range of travel times in the eastbound direction is low and the operating speed fairly high. Traffic in the westbound direction in the AM peak also experiences little congestion. However, traffic in the westbound direction in the PM peak experiences a wide range of travel times and speeds indicating congested conditions.

Table 4-15 Speed and Travel Time (2013) – Hills M2 Motorway, between Westlink M7 Motorway and Lane Cove Tunnel

Direction	Distance (km)	Range of Travel Times (min:sec)	Average Speeds (km/h)
AM Peak Period			
Eastbound	21.8	14:20-19:30	67-92
Westbound	21.5	13:50-16:50	77-93
PM Peak Period			
Eastbound	21.8	14:20-16:00	82-92
Westbound	21.5	14:20-36:30	36-90

(Source: Austraffic; 15 Oct 2013)

4.2.3 Operational assessment

4.2.3.1 Roadway level of service

The theoretical mid-block capacity for a single lane on the Hills M2 Motorway has been adopted as 2,300 passenger car units (PCU) per lane for the peak hour[7]. Mid-block volume/capacity ratios along the Hills M2 Motorway, east and west of Pennant Hills Road, under existing (2013) conditions for the AM and PM peak are provided in **Table 4-16** and **Table 4-17** respectively.

Table 4-16 Mid-block traffic volume and LoS: Existing 2013 – Hills M2 Motorway, east of Pennant Hills Road

Time	Direction	Mid-Block Capacity	Light Vehicles	Heavy Vehicles	V/C	LoS
AM peak hour	Eastbound	6,900	3,160	370	0.61	D
	Westbound	6,900	1,990	170	0.36	B
PM peak hour	Eastbound	6,900	2,500	160	0.43	C
	Westbound	6,900	3,870	310	0.69	D

Table 4-17 Mid-block traffic volume and LoS: Existing 2013 – Hills M2 Motorway, west of Pennant Hills Road

Time	Direction	Mid-Block Capacity	Light Vehicles	Heavy Vehicles	V/C	LoS
AM peak hour	Eastbound	6,900	3,700	490	0.71	D
	Westbound	4,600	2,620	240	0.68	C
PM peak hour	Eastbound	6,900	2,990	230	0.50	C
	Westbound	4,600	3,750	430	1.00	F

4.2.3.2 Intersection level of service

The assessment of the relevant intersection on the corridor, namely the Hills M2 Motorway / Pennant Hills Road interchange, is detailed in **Section 4.1.3.4**.

[7] Austroads, Guide to Traffic Management Part 3: Traffic Studies and Analysis, Second Edition, April 2013, page 63

4.3 M1 Pacific Motorway corridor

4.3.1 Travel times and speeds

Traffic on the M1 Pacific Motorway between the Central Coast Highway at Kariong and Pennant Hills Road was reported as operating at an average of 88 kilometres per hour in the inbound direction (southbound) in the AM peak period (5.45am-7.20am) and 87 kilometres per hour in the outbound direction (northbound) in the PM peak period (3pm-6.15pm), with a travel time range of 28 to 37 minutes in the inbound direction (southbound) in the AM peak period and 28 to 32 minutes in the outbound direction (northbound) in the PM peak period[8]. The high speeds and relatively small variance in travel time indicates there may be relatively little congestion on the M1 Pacific Motorway. However, this is measured over a long section of the motorway (43 kilometres) and smaller sections are likely to experience congestion, especially at the southern end of the motorway.

4.3.2 Operational assessment

4.3.2.1 Roadway level of service

The theoretical mid-block capacity for a single lane on the M1 Pacific Motorway has been adopted as 2,300 passenger car units (PCU) per lane for the peak hour[9]. Mid-block volume / capacity ratios along the motorway under existing (2013) conditions for the AM and PM peak are provided in **Table 4-18**.

Table 4-18 Mid-block traffic volumes and level of service: Existing 2013 – M1 Pacific Motorway, north of Pacific Highway

Time	Direction	Mid-Block Capacity	Light Vehicles	Heavy Vehicles	V/C	LoS
AM peak hour	Northbound	6,900	1,460	220	0.31	B
	Southbound	6,900	3,410	250	0.60	C
PM peak hour	Northbound	6,900	3,590	230	0.62	C
	Southbound	6,900	1,900	180	0.35	B

[8] Roads and Maritime Services, Key Roads Performance Report, June 2013
[9] Austroads, Guide to Traffic Management Part 3: Traffic Studies and Analysis, Second Edition, April 2013, page 63

4.4 Westlink M7 Motorway corridor

4.4.1 Travel times and speeds

Traffic on the Westlink M7 Motorway between the M4 Motorway and Abbott Road was reported as operating at an average of 86 kilometres per hour in the inbound direction (eastbound) in the AM peak period (6.30am-9am) and 92 kilometres per hour in the outbound direction (westbound) in the PM peak period (3pm-6.30pm), with a travel time range of 12 to16 minutes in the inbound direction (eastbound) in the AM peak period and 12 to13 minutes in the outbound direction (westbound) in the PM peak period[10]. The high speeds and small variance in travel time indicates relatively little congestion on the Westlink M7 motorway.

4.4.2 Operational assessment

4.4.2.1 Roadway level of service

The theoretical mid-block capacity for a single lane on the Westlink M7 Motorway has been adopted as 2,300 passenger car units (PCU) per lane for the peak hour[11]. Mid-block volume/capacity ratios along the motorway under existing (2013) conditions for the AM and PM peak are provided in **Table 4-19**.

Table 4-19 Mid-block traffic volumes and LoS: Existing 2013 – Westlink M7 Motorway

Location	Direction	Mid-Block Capacity	Light Vehicles	Heavy Vehicles	V/C	LoS
AM Peak Hour						
Old Windsor Road to Hills M2 Motorway	Eastbound	4,600	1,290	200	0.40	B
	Westbound	4,600	1,360	160	0.40	B
The Horsley Drive to Old Wallgrove Road	Northbound	4,600	2,190	470	0.77	D
	Southbound	4,600	2,210	470	0.78	D
PM Peak Hour						
Old Windsor Road to Hills M2 Motorway	Eastbound	4,600	1,590	130	0.43	B
	Westbound	4,600	2,130	220	0.60	C
The Horsley Drive to Old Wallgrove Road	Northbound	4,600	2,330	340	0.72	D
	Southbound	4,600	2,500	370	0.77	D

[10] Roads and Maritime Services, Key Roads Performance Report, June 2013
[11] Austroads, Guide to Traffic Management Part 3: Traffic Studies and Analysis, Second Edition, April 2013, page 63

5.0 Traffic modelling and forecasting process

5.1 Introduction to traffic modelling

This chapter provides details of the integrated traffic modelling and forecasting approach that was adopted for the traffic and transport assessment. This approach, as depicted in **Figure 5-1**, involved:

- Use of existing traffic counts (2013) to characterise existing traffic conditions and road network performance.
- Application of a strategic Sydney transport model (Cube traffic modelling package) to determine anticipated future growth in traffic on the major road network and the effects of tolling on road traffic demand.
- Use of strategic (Cube) and corridor (LinSig) traffic models to determine existing and future traffic conditions along the Pennant Hills Road corridor and key surrounding local roads. The outputs from these models have been used to assess the operational performance of the corridor and wider road network during construction and operation of the project.

The objective was to make the best use of existing traffic counts (December 2013), strategic (Cube) and corridor (LinSig) models to determine the existing and future conditions on the Pennant Hills Road corridor and key surrounding local roads and assess the performance of the network / corridor during construction (2016) and operation with and without the project. For the operational assessment, the assessed years correspond to the expected year of opening (2019) and in the future (2029).

The strategic modelling and traffic forecasting was undertaken by Transurban, who then provided the results for the corridor operational traffic modelling, which was undertaken by AECOM.

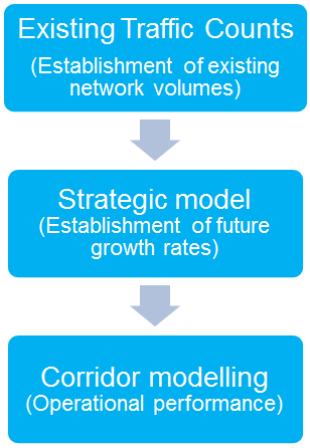

Figure 5-1 Overview of traffic modelling approach

5.2 Strategic model and traffic forecasting methodology

5.2.1 Overview

The strategic transport model was developed, progressively updated and enhanced, building from research, models and data files. As such, it provides the foundation for traffic predictions, and remains a comprehensive tool for estimating the impact of significant network changes in terms of both traffic and revenue implications on Sydney toll roads. The traffic model utilises the Cube Voyager software platform.

The forecasting approach comprises:

- A strategic highway network model of the Sydney metropolitan area including Sydney's motorway network and all major state roads within the network.
- Anticipated future land use as a basis for estimating future travel demand for cars and trucks.
- Anticipated changes and updates to the road network up until 2031.
- Representation of future vehicle travel demand to model varying travel patterns and behaviours.
- Explicit modelling of all tolls, existing and future, on the network.
- Accommodation of different motorist behaviours including willingness to pay a toll to save travel time.

The strategic transport model provides forecasting results for 2016, 2021, 2026, and 2031. Extrapolation between future modelled years was undertaken to establish network demands in 2019 and 2029 to represent the expected year of opening and in the future.

5.2.2 Strategic modelling assumptions

5.2.2.1 Land use projections

Land use forecasts consist of future projections in population and employment and are a key input to the traffic model when determining future travel demand and road network impacts. **Table 5-1** shows employment forecasts by statistical sub division (SSD) with highlights as follows:

- As with most Australian cities, the Sydney central business district is a major source of jobs / employment with Inner Sydney statistical sub division (which includes Sydney central business district but also Sydney Port and Domestic Air Terminals) has some 26 per cent of total regional employment.
- The statistical sub divisions of Central Northern Sydney, Central Western Sydney and Blacktown comprise 23 per cent of Sydney employment and lie within the catchment of the project.
- The statistical sub divisions of Central Northern Sydney, Central Western Sydney and Blacktown will capture approximately 23 per cent of the anticipated employment growth to 2031 or 75,000 jobs.
- The highest percentage increases are forecast to be in Outer South Western Sydney Blacktown and Fairfield-Liverpool and receive some 72,000 extra jobs representing about 22 per cent of the total regional employment growth of 334,000 jobs.

Table 5-2 shows population forecasts by SSD, with highlights as follows:

- It is expected that the population of Sydney would increase from 4.6 million people in 2011 to 5.4 million people by 2031. The majority of this growth will be Outer South Western Sydney and Blacktown and Central Northern Sydney.
- The sector with the highest population is St George-Sutherland with approximately 467,000 or ten per cent of Sydney's population and includes the statistical local areas of Rockdale (Sydney International Airport Terminal), Hurstville and Kogarah. Central Northern Sydney, through which the project runs, has a 2011 population of 460,000 people.
- Outer South Western Sydney, which includes a significant section of the South West Growth Centre including Camden, Campbelltown and Wollondilly, has the highest growth rate with 1.9 per cent per annum increase for the period through to 2031.
- Blacktown, Central Western Sydney, Gosford-Wyong have percentage growth of over one per cent and are expected to attract an additional 227,000 people for the period through to 2031.

Table 5-1 Employment changes in Sydney (2011-2031)

Sector	2011 Employment	2031 Employment	Absolute Growth (2011 to 2031)	Average Compound Growth Rate (2011 to 2031)
Inner Sydney	610,000	708,000	98,000	0.7%
Eastern Suburbs	99,000	107,000	8,000	0.4%
Inner Western Sydney	89,000	101,000	12,000	0.6%
Lower Northern Sydney	264,000	283,000	19,000	0.3%
Canterbury-Bankstown	110,000	125,000	15,000	0.6%
Fairfield-Liverpool	127,000	152,000	25,000	0.9%
Central Western Sydney	213,000	251,000	38,000	0.8%
Blacktown	105,000	125,000	20,000	0.9%
Central Northern Sydney	160,000	177,000	17,000	0.5%
Northern Beaches	102,000	109,000	7,000	0.3%
St George-Sutherland	156,000	167,000	11,000	0.3%
Outer South Western Sydney	84,000	111,000	27,000	1.4%
Outer Western Sydney	120,000	140,000	20,000	0.8%
Gosford-Wyong	115,000	133,000	18,000	0.7%
Total Sydney	**2,355,000**	**2,689,000**	**334,000**	**0.7%**

(Source: Transurban; 2014)

Table 5-2 Population changes in Sydney (2011-2031)

Sector	2011 Population	2031 Population	Absolute Growth (2011 to 2031)	Average Compound Growth Rate (2011 to 2031)
Inner Sydney	364,000	433,000	69,000	0.9%
Eastern Suburbs	260,000	278,000	18,000	0.3%
Inner Western Sydney	194,000	225,000	31,000	0.7%
Lower Northern Sydney	320,000	356,000	36,000	0.5%
Canterbury-Bankstown	334,000	364,000	30,000	0.4%
Fairfield-Liverpool	387,000	463,000	76,000	0.9%
Central Western Sydney	355,000	430,000	75,000	1.0%
Blacktown	308,000	391,000	83,000	1.2%
Central Northern Sydney	460,000	541,000	81,000	0.8%
Northern Beaches	247,000	279,000	32,000	0.6%
St George-Sutherland	467,000	488,000	21,000	0.2%

Sector	2011 Population	2031 Population	Absolute Growth (2011 to 2031)	Average Compound Growth Rate (2011 to 2031)
Outer South Western Sydney	261,000	378,000	117,000	1.9%
Outer Western Sydney	333,000	395,000	62,000	0.9%
Gosford-Wyong	325,000	394,000	69,000	1.0%
Total Sydney	**4,616,000**	**5,415,000**	**799,000**	**0.8%**

(Source: Transurban; 2014)

5.2.2.2 Toll assumptions

The modelled toll prices for the project for car and truck are $6.11 for cars and $18.32 for trucks in $2013. Toll prices would increase in line with the proposed concession agreement with the Government. The concession for the project would continue to 2048.

Key changes to tolling in accordance with the project relate to the Westlink M7 Motorway where truck tolls would increase from the same as the car toll to three times the car toll.

5.2.2.3 Freight assumptions

By 2031, the freight task in NSW is projected to nearly double to 794 million tonnes. The volumes of all commodities are expected to grow as population and economic activity increases. Capacity across the freight network varies, but key parts of the network are already constrained. Of the 409 million tonnes moved on the NSW transport network in 2011, the road network carried around 256 million tonnes (63 per cent), with the M1 Pacific Motorway and the M31 Hume Highway, the most frequently used road corridors, and rail carried about 33 per cent. The mode share for the total interstate freight task is 92 per cent by road and eight per cent by rail[12].

Freight modal data from 2001 shows that rail mode share decreased from 37 per cent to 33 per cent in 2011[13]. There is limited available freight capacity on the shared rail network in the metropolitan area, and priority for passenger trains in the rail timetables further constrains freight movements.

Completion of the North Sydney Freight Corridor project, which includes the Epping to Thornleigh Third Track (ETTT) Project, will expand the Main North Line's freight capacity, mainly focused on freight movement between Sydney and Newcastle. However, it is likely that any future capacity increase as a result of the ETTT project will be taken up by the projected freight growth by 2031, and is unlikely to impact on the heavy vehicle movements on Pennant Hills Road.

The 2004 report[14] of the investigation into a preferred option for a new road link between the F3 Freeway (now the M1 Pacific Motorway) and the Sydney Orbital Network, investigated a rail and public transport only option, which included investment to increase market share in passenger and freight rail, as well as replacing the investment in the new link with a new passenger rail service. The rail and public transport only option was based on the implementation of all planned rail infrastructure improvements plus additional investment in lieu of expenditure on a road link. These improvements included the North West Rail Link (Epping to Rouse Hill), the full Chatswood to Parramatta rail link, the ETTT Project, the Main North Line upgrade between Hornsby and Wyong, quadruplication of Strathfield to Hornsby line and two completely new train services linking the Central Coast with Parramatta and Western Sydney were included in the 2021 network, as well as the completion of the bus Transitways listed in *Action for Transport 2010.*

The 2004 report found that rail and public transport alone and in particular rail transport would be unlikely to satisfy future growth in transport demand. In relation to rail freight, the investigation found that the high rail freight growth scenario would only remove around ten per cent of trucks off Pennant Hills Road per day, resulting in a significant number of trucks still using Pennant Hills Road.

[12] Transport for NSW, NSW Freight and Ports Strategy, November 2013
[13] Australian Bureau of Statistics, 2011
[14] SKM, F3 to Sydney Orbital Link Study,2004

A number of projects identified above, such as North West Rail Link (NWRL) and the ETTT Project have either commenced construction or are in the final stages of planning. These projects would be undertaken concurrently with the project. However, they would be unlikely to satisfy future transport demand and would cater for different markets and objectives than the project. Both of these rail projects would enhance the existing rail infrastructure however they are unlikely to improve conditions on Pennant Hills Road.

Based on the above, no changes in future freight volumes (i.e. heavy vehicle movements) due to the NWRL or ETTT projects have been assumed in the strategic model.

5.2.2.4 Assumptions on heavy vehicle regulation on Pennant Hills Road

One of the key objectives of NorthConnex is to contribute towards a reduction in the number of heavy vehicles using Pennant Hills Road and as a result improve amenity along this corridor. This objective goes hand-in-hand with improving freight efficiency around and through Sydney, as well as providing opportunities for improved public transport in the area.

To achieve this, Roads and Maritime and Transport for NSW may introduce regulatory measures on the surrounding road network, including introducing, or changing the operation of existing, traffic control facilities, advisory and / or regulatory signage, route designations, notices, application of permits, or other traffic measures. Any regulatory measures that have the effect of regulating heavy vehicles would need to be consistent with the objectives of the National Heavy Vehicle Law, where applicable. Some trucks would be exempt from any requirement to use the tunnel, such as:

- Those prohibited by law from using tunnels, such as trucks carrying dangerous goods or over-size trucks.
- Public passenger vehicles and emergency vehicles.
- Those that have a genuine destination or commencement point that could only be reasonably reached by Pennant Hills Road.

The exact approach to enforcing this is still to be confirmed, but the strategic model has assumed that all heavy vehicles, aside from those listed above, do not travel on Pennant Hills Road.

5.2.2.5 Existing traffic model network assumptions

The baseline road network adopted for the strategic model was the situation as it existed in 2011.

5.2.2.6 Forecasting future growth and impacts of the project

For the future ‘without project’ and ‘with project’ scenarios, the following methodology and network changes were assumed:

Step 1: Determine ‘without project’ growth (2011-2016)

- Generate a 2016 road network with the following major changes to the 2011 network:
    - Hills M2 Motorway Upgrade project including widening of the Hills M2 Motorway, Windsor Road and Herring/ Christie Road ramps.
    - Lane Cove Road ramp to the Hills M2 Motorway.
    - M5 Widening between King Georges Rd to the Westlink M7 Motorway.
    - Road network to support the North West and South West Growth Centres, including Richmond Road, Schofields Road and Northern Road.
- Interpolate between 2011 and 2016 model results to determine forecast 2013 traffic in the study area.

Step 2: Determine 'without project' growth (2016-2021)

- Generate a 2021 road network with the following changes to the 2016 network:
  - WestConnex Stage 1
  - WestConnex Stage 2
  - Road network enhancements to support the North West and South West Growth Centres.
- Interpolate between 2016 and 2021 model results and determine forecast 2019 traffic.
- Compare forecast 2013 and 2019 traffic and determine incremental difference between 2013 and 2019.
- Apply incremental difference to observed 2013 traffic to estimate 2019 traffic conditions in the study area without the project.

Step 3: Determine 'without project' growth (2021-2026)

- Generate 2026 road network with the following changes to the updated 2021 network:
  - WestConnex Stage 3
  - Road network enhancements to support the North West and South West Growth Centres.

Step 4: Determine 'without project' growth (2026-2031)

- Generate 2031 road network with changes to the updated 2026 network including road network enhancements to support the North West and South West Growth Centres.
- Interpolate between 2026 and 2031 model results and determine forecast 2029 traffic.
- Compare forecast 2013 and 2029 traffic and determine incremental difference between 2013 and 2029.
- Apply incremental difference to observed 2013 traffic to estimate 2029 traffic conditions in the study area without the project.

Step 5: Determine project and Westlink M7 Motorway truck tolling change impacts

- Recode the 2016, 2021, 2026 and 2031 networks within the strategic model as detailed above in Step 1 to Step 4 to include the project.
- Incorporate truck toll changes on the Westlink M7 Motorway.
- Run the 2016, 2021, 2026, and 2031 models with the project and toll changes.
- Interpolate between 2016 and 2021 model results to estimate 2019 traffic with the project.
- Interpolate between 2026 and 2031 model results to estimate 2029 traffic with the project.
- Compare forecast 2013 and 2019 traffic with the project and determine incremental difference between 2013 and 2019, and the incremental difference between 2013 and 2029.

The outputs of the strategic model for 2019 and 2029 with and without the project, and the resulting incremental increase, were then used in the corridor (LinSig) traffic models. This is discussed further in **Section 5.3**.

5.2.2.7 Induced traffic

Traffic growth on new or upgraded roads is generally a result of the following influences:

- Regional growth in trips resulting from population growth and expanded economic activity.
- Trips attracted from competing routes or modes as a result of improved travel times on the new or upgraded road.
- Induced traffic as a result of improved travel times between homes and destinations such as workplaces, shopping centres and education precincts which stimulate changes to regional-wide trip patterns.

Even with no growth in regional population and economic activity, a new or substantially upgraded road can induce changes in trip patterns which then appear as induced traffic. Generally, changes to home/workplace trip patterns would occur over several years after opening of the new or upgraded road, whereas changes to shopping and recreational trip patterns can occur in a much shorter period.

The strategic model includes the changes associated with population growth and economic activity, as well the reassignment of traffic within the network that takes advantage of the travel time savings generated by the new project. Induced demand from other transport modes has not been considered in either with or without project scenarios, as there are no parallel or competing public transport routes along the proposed route alignment for the same market that would use the NorthConnex tunnel. As such, minimal induced demand would be expected as a result of the project.

5.3 Corridor operational traffic modelling methodology

The modelling methodology used to forecast future traffic volumes for the project, incorporated the following two key stages and sub-tasks:

1) Derivation of base year traffic patterns.

2) Base and future year model development.

5.3.1 Derivation of base year traffic patterns

The primary stage in the traffic modelling process is to construct an accurate representation of base year traffic patterns on the network. In order to ensure an accurate representation of existing conditions, network traffic counts, shown in **Figure 5-2**, were gathered across the corridor. These informed the base year models to be used in both the construction and operational assessments.

5.3.2 Base and future year model development

5.3.2.1 Selection of appropriate modelling tool and calibration/validation

To accurately model the road network and assess the existing and future (construction, without project and with project) scenarios, the LinSig corridor modelling software was chosen. LinSig is a macro-simulation model capable of assessing the performance of isolated or co-ordinated networks of traffic intersections. It is Road and Maritime's preferred software package in this line of work. One of the strengths of LinSig is that it allows for the optimisation of traffic signal timings across the network in accordance with the release of traffic across the network, therefore providing for the greatest network benefits to be captured.

To ensure the accurate representation of existing traffic conditions, the base models were calibrated and validated to align with existing operating conditions on the corridor. The following data sources were used in the calibration and validation process:

- Intersection turning counts.
- Intersection diagnostic monitor data (IDM).
- Signalised intersection intergreen timings.
- Saturation flows.
- Site visits to ensure dead green time, pedestrian delays, intergreen running were captured as well as posted speed limits, intersections configurations, lane usage, location of parking (if applicable), bus stop locations, bottlenecks and pinchpoints on the study corridor.

5.3.2.2 Traffic demand – base year model

Corridor assignment in LinSig uses origin-destination (OD) assignment via origin-destination demand matrices formulated within the software. These are based on the creation of a balanced network diagram referenced to surveyed traffic conditions. Vehicles enter and exit the road network via a series of zones which represent key locations or strategic roads within the study area. Light vehicles and heavy vehicles are inserted into the model in a format known as passenger car units (PCU). These are based on the acknowledgement of the amount of road space differing types of vehicles utilise. The passenger car unit factors applied in the base, and future, models for light and heavy vehicles are shown in **Table 5-3**. Although a car is nominated as 5.5 metres for one passenger car unit, the actual value of one passenger car unit is equivalent to 6.25 metres to take into consideration the impact of the space left between queuing vehicles.

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Figure 5-2 Traffic count locations

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Table 5-3 PCU Factor

Vehicle Type	PCU Factor	Physical length (approx.)	Source
Car	1	5.5 metres	N/A
Articulated truck	2.9	11.5 metres – 19 metres	UK, Department of Transport
Truck and dog	2.0	19 metres	UK, Department of Transport

(Source: Roads and Maritime; Traffic Modelling Guidelines; 2013)

The models developed during this study represent AM and PM peak hour periods; origin-destination matrices have been developed to reflect one hour demand volumes.

5.3.2.3 Base year model development

It is standard modelling practice to create a base model to replicate existing traffic conditions before developing any future scenarios. Base models were created for the locations shown in **Figure 5-3** and in **Table 5-4**. These models were constructed and calibrated, using the tools discussed in **Section 5.3.2.1** to ensure that accurate modelling of construction and operations could be undertaken on the corridor. Modelling has been undertaken using the lane configurations available within LinSig.

Table 5-4 Model extents

Model Number	Extent of Model
Model 1	- Pennant Hills Road / North Rocks Road - Hills M2 Motorway / Pennant Hills Road - Pennant Hills Road / Eaton Road / Copeland Road - Pennant Hills Road / Aiken Road
Model 2	- Pennant Hills Road / Beecroft Road West - Pennant Hills Road / Beecroft Road East - Pennant Hills Road / Boundary Road
Model 3	- Pennant Hills Road / Jasmine Road - Pennant Hills Road / Hinemoa Road - M1 Pacific Motorway / Pennant Hills Road - Pennant Hills Road / Pacific Highway - M1 Pacific Motorway / Pacific Highway - Pacific Highway / Ingram Street
Model 5	- Pennant Hills Road / Duffy Avenue - Pennant Hills Road / Dartford Road - Dartford Road / Sefton Road - Chilvers Road / The Esplanade / Duffy Avenue - Sefton Road / Chilvers Road
Model 6	- Pennant Hills Road / Phyllis Avenue - Pennant Hills Road / Comenarra Parkway - Pennant Hills Road / Bellevue Street
Model 7	- Pennant Hills Road / Yarrara Road - Pennant Hills Road / The Crescent
Model 11	- Pennant Hills Road / Castle Hill Road

Note: Models 4, 8, 9 and 10 were created initially but became redundant during the environmental impact statement process. Numbering has been retained for consistency and recording reasons.

(Source: AECOM, 2014)

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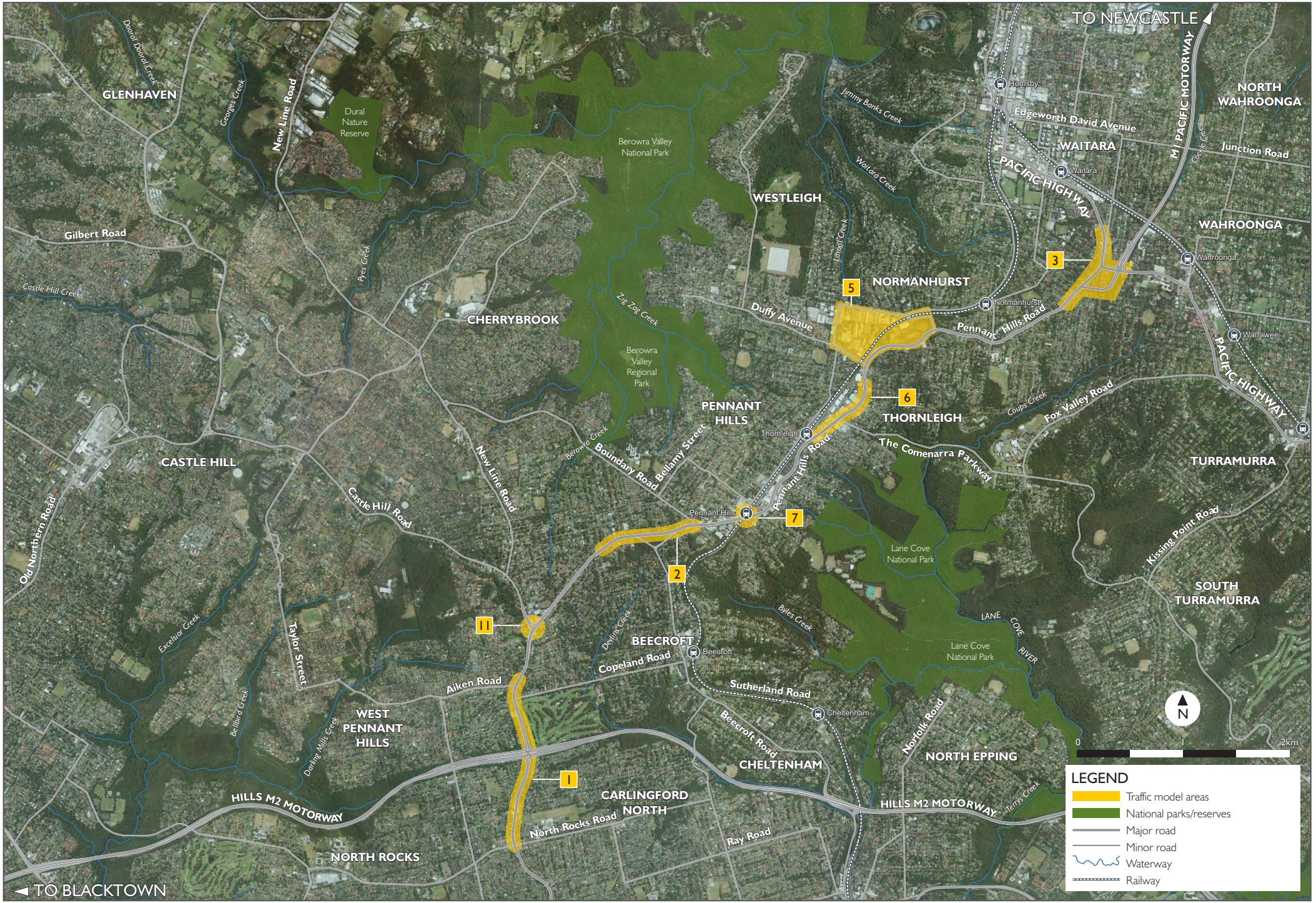

Figure 5-3 Traffic model locations

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5.3.2.4 Future year model development

Models representing the analysis years of 2019 and 2029 were developed to assess the future performance of the Pennant Hills Road corridor. The year 2019 was selected as a future scenario year as this is the proposed opening year of the project. Likewise, the year 2029 was chosen as this represents the project opening plus 10 years, enabling a comparison of how the road network is expected to perform just after the project has opened, and once traffic patterns have become accustomed to the changes brought about by the project.

These 2019 and 2029 models catered for the assessment of the 'with project' and 'without project' scenarios. In addition, a 2016 construction scenario was developed which assessed the effects of construction traffic on the network. The results of the future year corridor modelling are included in **Section 5** and **Section 7**.

Future year flow development

The future network volumes have been determined through reference to the strategic model and the surveyed traffic counts in a method known as 'differential growth'. Using the differential growth approach, future traffic growth is determined from the strategic model for each intersection movement over the desired time period. For example, the 2013 AM peak hour to 2019 AM peak hour. This growth in absolute volume is then added to the surveyed 2013 traffic volume to provide the future flow for that time period. This methodology provides the most accurate representation of how the modelled future traffic growth would affect existing network demands and the resultant network operation.

In rare cases, such as when an alternate route is introduced and flows fall substantially on the corridor, the potential to achieve negative future year volumes can occur. As a result, a robust analysis of future volumes was undertaken whereby, in the event that a flow decreased to less than 20 per cent of the known (surveyed) flow, a 'percentage reduction' method was applied to the existing flow to generate the future volume on that link. This method was required for the 'with project' scenario for heavy vehicles, due to the large drop in volume on the Pennant Hills Road surface corridor caused by the introduction of the project.

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6.0 Future conditions without the project

This section details the forecast future performance of the Pennant Hills Road and Hills M2 Motorway corridor during the 'without project' scenario. The forecast roadway level of service (mid-block assessment) has been undertaken using forecast AM and PM peak traffic volumes for the project design year (2019) and the opening plus ten years (2029). Intersection level of service, based on the capacity and efficiency of key intersections along the Pennant Hills Road corridor, has been assessed using LinSig corridor modelling software. **Figure 6-1** identifies the key mid-blocks and intersections assessed in this technical working paper.

6.1 Pennant Hills Road corridor and Pacific Highway corridor

6.1.1 Traffic volumes and patterns

Table 6-1 provides the forecast AM and PM peak hour volumes for 2019 and 2029 without the project compared to the existing 2013 light and heavy vehicle volumes.

Table 6-1 Comparison between 2013 and 2019 'without project' traffic flows

Intersection / interchange	Light vehicles			Heavy vehicles		
	2013	2019	2029	2013	2019	2029
AM Peak Hour						
Pennant Hills Road / North Rocks Road	4,090	4,870	5,650	280	340	440
Hills M2 Motorway / Pennant Hills Road	5,410	6,320	7,380	600	680	860
Pennant Hills Road / Copeland Road	5,320	6,100	6,950	560	640	820
Pennant Hills Road / Castle Hill Road	4,720	5,130	5,580	550	590	700
Pennant Hills Road / Beecroft Road (S)	5,140	5,650	6,320	470	540	670
Pennant Hills Road / Beecroft Road (N)	6,150	6,810	7,680	490	560	710
Pennant Hills Road / Boundary Road	6,120	6,860	7,640	540	630	760
Pennant Hills Road / Comenarra Parkway	4,510	5,160	5,880	590	680	780
M1 Pacific Motorway / Pennant Hills Road	4,010	4,500	5,020	490	540	620
Pennant Hills Road / Pacific Highway	2,950	3,280	3,680	200	220	250
M1 Pacific Motorway / Pacific Highway	4,450	4,860	5,340	240	290	370
PM Peak Hour						
Pennant Hills Road / North Rocks Road	4,540	5,190	5,950	170	210	300
Hills M2 Motorway / Pennant Hills Road	5,780	6,530	7,280	480	540	660
Pennant Hills Road / Copeland Road	5,750	6,430	7,180	470	530	650
Pennant Hills Road / Castle Hill Road	5,790	6,290	6,850	440	490	590
Pennant Hills Road / Beecroft Road (S)	5,510	5,910	6,430	390	450	560
Pennant Hills Road / Beecroft Road (N)	5,890	6,330	6,810	410	470	590
Pennant Hills Road / Boundary Road	6,390	6,980	7,610	450	560	720
Pennant Hills Road / Comenarra Parkway	5,200	5,810	6,380	440	530	670
M1 Pacific Motorway / Pennant Hills Road	4,550	4,870	5,290	380	430	560
Pennant Hills Road / Pacific Highway	3,330	3,560	3,970	110	130	170
M1 Pacific Motorway / Pacific Highway	4,970	5,190	5,560	120	150	190

(Source: Strategic transport model, 2014)

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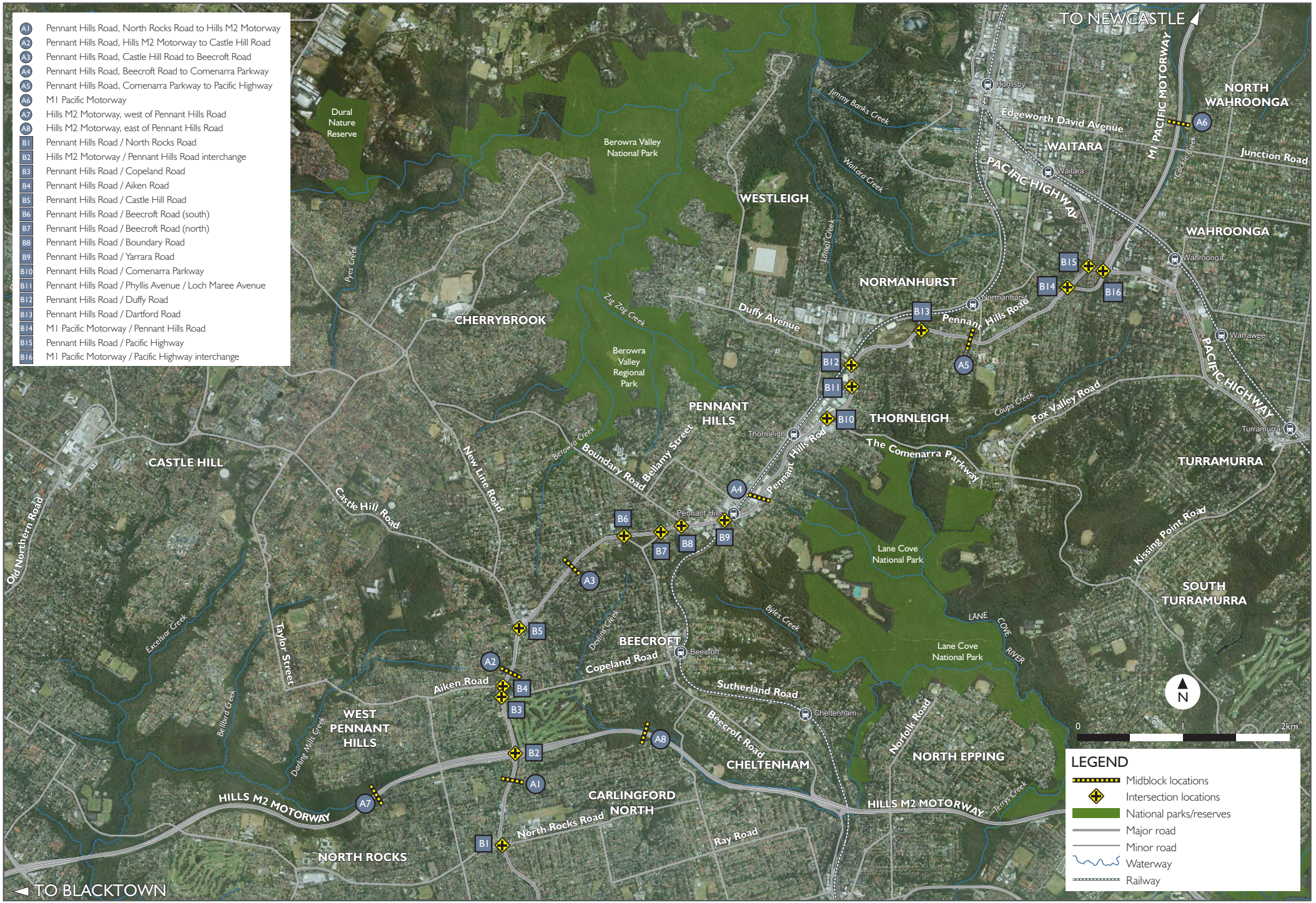

Figure 6-1 Assessed mid-blocks and intersections

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Mid-block average weekday daily traffic (AWDT) volumes on the Pennant Hills Road and Pacific Highway corridor in the 2019 and 2029 'without project' scenario have been collated and compared to the existing 2013 AWDT volumes as shown in **Table 6-2**.

The AWDT figures on Pennant Hills Road for 2019 range from 27,850 northbound in the south of the corridor between North Rocks Road and the Hills M2 Motorway, to 50,200 northbound between Beecroft Road and Comenarra Parkway. In the 2029 scenario without the project, volumes similarly range from 32,400 northbound in the south of the corridor to 56,000 northbound between Beecroft Road and Comenarra Parkway.

Table 6-2 Pennant Hills Road corridor modelled AWDT volumes: 2019 and 2029 without project

Location	Direction	AWDT (vehicles per day)	
		2019	2029
Pennant Hills Road, North Rocks Road to Hills M2 Motorway	Northbound	27,850	32,400
	Southbound	32,000	38,750
Pennant Hills Road, Hills M2 Motorway to Castle Hill Road	Northbound	45,750	50,850
	Southbound	47,800	53,650
Pennant Hills Road, Castle Hill Road to Beecroft Road	Northbound	36,800	39,400
	Southbound	35,400	38,150
Pennant Hills Road, Beecroft Road to Comenarra Parkway	Northbound	50,200	56,000
	Southbound	46,100	51,700
Pennant Hills Road, Comenarra Parkway to Pacific Highway	Northbound	35,650	39,750
	Southbound	34,850	39,400
Pacific Highway, north of Pennant Hills Road	Northbound	20,200	21,800
	Southbound	20,450	22,350
Pacific Highway, east of M1 Pacific Motorway Interchange	Northbound	33,550	37,100
	Southbound	34,850	38,000

(Source: Strategic transport model, 2014)

6.1.2 Roadway level of service

A comparison of the mid-block traffic volumes and levels of service along the Pennant Hills Road and Pacific Highway corridor under the 'without project' scenario are provided for 2019 and 2029 in **Table 6-3** and **Table 6-4**.

Table 6-3 Mid-block traffic volumes and level of service (2019 without project)

Location	Direction	Mid-Block Capacity	Light Vehicles	Heavy Vehicles	V/C	LoS
AM Peak Hour						
Pennant Hills Road, North Rocks Road to Hills M2 Motorway	Northbound	2,800	1,590	180	0.76	D
	Southbound	2,800	2,320	130	0.96	E
Pennant Hills Road, Hills M2 Motorway to Castle Hill Road	Northbound	4,200	2,330	350	0.80	D
	Southbound	4,200	3,220	250	0.94	E
Pennant Hills Road, Castle Hill	Northbound	4,200	2,540	290	0.81	E

Location	Direction	Mid-Block Capacity	Light Vehicles	Heavy Vehicles	V/C	LoS
Road to Beecroft Road	Southbound	4,200	2,200	210	0.67	D
Pennant Hills Road, Beecroft Road to Comenarra Parkway	Northbound	4,200	3,430	340	1.05	F
	Southbound	4,200	3,380	210	0.95	E
Pennant Hills Road, Comenarra Parkway to Pacific Highway	Northbound	4,200	2,140	290	0.71	D
	Southbound	4,200	2,340	270	0.75	D
Pacific Highway, north of Pennant Hills Road	Northbound	2,800	1,470	100	0.63	D
	Southbound	4,200	1,150	80	0.33	B
Pacific Highway, east of M1 Pacific Motorway Interchange	Northbound	4,200	1,600	120	0.46	C
	Southbound	4,200	3,000	170	0.83	E
PM Peak Hour						
Pennant Hills Road, North Rocks Road to Hills M2 Motorway	Northbound	2,800	2,080	50	0.80	D
	Southbound	2,800	1,980	140	0.86	E
Pennant Hills Road, Hills M2 Motorway to Castle Hill Road	Northbound	4,200	3,640	190	1.00	E
	Southbound	4,200	2,970	310	0.92	E
Pennant Hills Road, Castle Hill Road to Beecroft Road	Northbound	4,200	2,450	160	0.69	D
	Southbound	4,200	2,250	290	0.73	D
Pennant Hills Road, Beecroft Road to Comenarra Parkway	Northbound	4,200	3,690	180	1.00	F
	Southbound	4,200	2,830	330	0.90	E
Pennant Hills Road, Comenarra Parkway to Pacific Highway	Northbound	4,200	2,890	170	0.81	D
	Southbound	4,200	2,970	310	0.92	E
Pacific Highway, north of Pennant Hills Road	Northbound	2,800	1,300	30	0.50	C
	Southbound	4,200	1,630	70	0.44	C
Pacific Highway, east of M1 Pacific Motorway Interchange	Northbound	4,200	3,030	80	0.78	D
	Southbound	4,200	1,790	60	0.47	C

Growth in background traffic has resulted in a decreased level of mid-block performance in 2019. In particular, the section of Pennant Hills Road between Beecroft Road and Comenarra Parkway in the northbound direction is forecast to operate with peak traffic volumes above the theoretical design capacity of the road. The PM peak analysis shows that the northbound section of Pennant Hills Road from Hills M2 Motorway to Castle Hill Road is expected to be at the theoretical design capacity of the road in 2019. Several other sections of Pennant Hills Road approach capacity under forecast 2019 traffic volumes, with volume / capacity ratios in excess of 0.90.

Under the forecast traffic growth for 2029, further sections of Pennant Hills Road are expected to exceed the theoretical design capacity of the road. In the AM peak, the southbound section from North Rocks Road to Castle Hill Road is expected to exceed the theoretical design capacity of the road. In addition, the southbound section from Beecroft Road to Comenarra Parkway operates at a level of service F, while the northbound section remains beyond capacity as in 2019.

Table 6-4 Mid-block traffic volumes and LoS (2029 without project)

Location	Direction	Mid-Block Capacity	Light Vehicles	Heavy Vehicles	V/C	LoS
AM Peak Hour						
Pennant Hills Road, North Rocks Road to Hills M2 Motorway	Northbound	2,800	1,810	240	0.90	E
	Southbound	2,800	2,840	170	1.19	F
Pennant Hills Road, Hills M2 Motorway to Castle Hill Road	Northbound	4,200	2,470	400	0.86	E
	Southbound	4,200	3,620	320	1.09	F
Pennant Hills Road, Castle Hill Road to Beecroft Road	Northbound	4,200	2,750	320	0.88	E
	Southbound	4,200	2,370	260	0.74	D
Pennant Hills Road, Beecroft Road to Comenarra Parkway	Northbound	4,200	3,750	430	1.19	F
	Southbound	4,200	3,930	280	1.13	F
Pennant Hills Road, Comenarra Parkway to Pacific Highway	Northbound	4,200	2,290	340	0.78	D
	Southbound	4,200	2,690	310	0.85	E
Pacific Highway, north of Pennant Hills Road	Northbound	2,800	1,570	80	0.64	D
	Southbound	4,200	1,200	90	0.35	B
Pacific Highway, east of M1 Pacific Motorway Interchange	Northbound	4,200	1,800	160	0.54	C
	Southbound	4,200	3,240	130	0.86	E
PM Peak Hour						
Pennant Hills Road, North Rocks Road to Hills M2 Motorway	Northbound	2,800	2,420	60	0.93	E
	Southbound	2,800	2,280	220	1.04	F
Pennant Hills Road, Hills M2 Motorway to Castle Hill Road	Northbound	4,200	4,050	240	1.13	F
	Southbound	4,200	2,620	370	1.05	F
Pennant Hills Road, Castle Hill Road to Beecroft Road	Northbound	4,200	2,560	170	0.73	D
	Southbound	4,200	2,400	340	0.80	D
Pennant Hills Road, Beecroft Road to Comenarra Parkway	Northbound	4,200	4,080	240	1.14	F
	Southbound	4,200	2,990	410	1.00	E
Pennant Hills Road, Comenarra Parkway to Pacific Highway	Northbound	4,200	3,140	230	0.90	E
	Southbound	4,200	3,300	380	1.05	F
Pacific Highway, north of Pennant Hills Road	Northbound	2,800	1,420	70	0.58	C
	Southbound	4,200	1,830	100	0.50	C
Pacific Highway, east of M1 Pacific Motorway Interchange	Northbound	4,200	3,270	100	0.85	E
	Southbound	4,200	1,900	110	0.53	C

6.1.3 Intersection level of service

Table 6-5 provides a summary of the intersection performance (level of service) at key locations on the Pennant Hills Road corridor under the forecast 2019 and 2029 (without project) peak hour traffic volumes. The forecast AM and PM traffic volumes includes growth within the future road network without the introduction of the project. The analysis provides the average intersection delay and the intersection Level of Service (LoS).

Table 6-5 2019 and 2029 Intersection performance: Without project (AM and PM Peak Hour)

Intersection/Peak	2019 – Without Project				2029 – Without Project			
	Light Vehicles	Heavy Vehicles	Average Delay	Level of Service	Light Vehicles	Heavy Vehicles	Average Delay	Level of Service
Pennant Hills Road / North Rocks Road								
AM Peak	4,870	340	>100	F	5,650	440	>100	F
PM Peak	5,190	210	>100	F	5,950	300	>100	F
Hills M2 Motorway / Pennant Hills Road interchange								
AM Peak	6,320	680	51.4	D	7,380	860	>100	F
PM Peak	6,530	540	>100	F	7,280	660	>100	F
Pennant Hills Road / Copeland Road								
AM Peak	6,100	640	>100	F	6,950	820	>100	F
PM Peak	6,430	530	>100	F	7,180	650	>100	F
Pennant Hills Road / Aiken Road								
AM Peak	5,570	620	63.9	E	6,190	750	>100	F
PM Peak	6,810	520	27.8	B	7,560	640	61.9	E
Pennant Hills Road / Castle Hill Road								
AM Peak	5,130	590	18.7	B	5,580	700	>100	F
PM Peak	6,290	490	95.5	F	6,855	590	>100	F
Pennant Hills Road / Beecroft Road (South)								
AM Peak	5,650	540	>100	F	6,320	670	>100	F
PM Peak	5,910	450	>100	F	6,430	560	>100	F
Pennant Hills Road / Beecroft Road (North)								
AM Peak	6,810	560	>100	F	7,680	710	>100	F
PM Peak	6,330	470	16.3	B	6,810	590	51.0	D
Pennant Hills Road / Boundary Road								
AM Peak	6,860	630	63.2	E	7,640	760	>100	F
PM Peak	6,980	560	41.1	C	7,610	720	72.7	F
Pennant Hills Road / Yarrara Road								
AM Peak	6,070	620	>100	F	6,700	730	>100	F
PM Peak	6,350	550	>100	F	6,890	710	>100	F

Intersection/Peak	2019 – Without Project				2029 – Without Project			
	Light Vehicles	Heavy Vehicles	Average Delay	Level of Service	Light Vehicles	Heavy Vehicles	Average Delay	Level of Service
Pennant Hills Road / Comenarra Parkway								
AM Peak	5,160	680	>100	F	5,880	780	>100	F
PM Peak	5,810	530	>100	F	6,380	670	>100	F
M1 Pacific Motorway / Pennant Hills Road								
AM Peak	4,500	540	45.5	D	5,020	620	>100	F
PM Peak	4,870	430	79.5	F	5,290	560	>100	F
Pennant Hills Road / Pacific Highway								
AM Peak	3,280	220	>100	F	3,680	250	>100	F
PM Peak	3,560	130	53.2	D	3,970	170	>100	F
M1 Pacific Motorway / Pacific Highway interchange								
AM Peak	4,860	290	94.5	F	5,340	370	>100	F
PM Peak	5,190	150	69.1	E	5,560	190	>100	F

The intersection performance results above demonstrate that all key intersections along the Pennant Hills Road corridor would experience significant congestion during the AM and PM peak hours in both 2019 and 2029. As detailed in **Section 4.1.3.4**, the analysis of the existing corridor illustrated a number of key intersections operate at or close to capacity. It is important to appreciate, once the intersection demands exceed capacity, the values for average delay increase substantially.

The quantum of light and heavy vehicle growth occurs primarily along the Pennant Hills Road corridor and at key locations such as Castle Hill Road, Boundary Road, Comenarra Parkway and the interchanges located at either end of the corridor.

The 2019 'without project' scenario analysis illustrates a decrease in the corridor performance with the addition of background traffic growth. The intersections in the vicinity of the Hills M2 Motorway / Pennant Hills Road interchange experience an increase in average intersection delay, particularly during the AM peak period. The 2019 scenario intersections where traffic demand exceeds the capacity of the turning movements by more than 15 per cent include:

- Pennant Hills Road / Copeland Road (AM peak).
- Pennant Hills Road / Castle Hill Road (PM peak).
- Pennant Hills Road / Beecroft Road (south) (PM peak).
- Pennant Hills Road / M1 Pacific Motorway (AM peak).

The 2029 'without project' scenario analysis demonstrates a further reduction in corridor performance with the addition of background traffic growth from 2019. All key intersections assessed along the Pennant Hills Road corridor experience a significant increase in average delay, with the majority achieving only level of service F intersection performance. The only exception is Pennant Hills Road / Beecroft Road intersection which has only a single conflicting movement.

6.1.4 Travel times

6.1.4.1 Pennant Hills Road

A comparison of average travel time between 2019 and 2029 for Pennant Hills Road between the Hills M2 Motorway / Pennant Hills Road interchange and the M1 Pacific Motorway / Pennant Hills Road intersection, a distance of eight kilometres, is presented in **Table 6-6**. These travel times have been provided from the strategic transport model. The 2013 travel time from the strategic model is also presented for comparison.

The assessment of peak direction travel time showed deterioration along the Pennant Hills Road corridor without the project. The northbound journey on Pennant Hills Road in the 2019 PM peak would take approximately 12 minutes longer to complete. By 2029, this would continue to deteriorate with an increase in travel time of a further 15 minutes. A similar effect is observed in the southbound direction in the AM peak.

Table 6-6 Comparison of average travel time (2013, 2019 and 2029 without project) – Pennant Hills Road Corridor, between M1 Pacific Motorway intersection and Hills M2 Motorway interchange

Direction	AM Peak Hour Average Travel Time (min)			PM Peak Hour Average Travel Time (min)		
	2013	2019	2029	2013	2019	2029
Northbound	14	16	18	19	31	46
Southbound	18	27	39	13	16	19

(Source: Strategic transport model, 2014)

6.1.4.2 Pacific Highway

A comparison of average travel time between 2019 and 2029 for the section of the Pacific Highway between the M1 Pacific Motorway / Pacific Highway interchange and the Pacific Highway / Ryde Road / Mona Vale Road interchange, a distance of 5.4 kilometres, was provided from the strategic transport model. The results are shown in **Table 6-7**. The 2013 travel time from the strategic transport model is also presented for comparison.

As with the Pennant Hills Road corridor, the Pacific Highway experiences a significant increase in travel time in the peak period in the peak direction. While the reduction in performance is not as significant as on Pennant Hills Road, the southbound average travel time in the 2019 AM peak increases by five minutes compared to the 2013 travel time. By 2029, the average travel time for this movement is expected to increase by a further nine minutes. A similar effect is observed in the northbound direction in the PM peak.

Table 6-7 Comparison of average travel time (2013, 2019 and 2029 without project) – Pacific Highway Corridor, between M1 Pacific Motorway and Ryde Road / Mona Vale Road interchanges

Direction	AM Peak Hour Average Travel Time (min)			PM Peak Hour Average Travel Time (min)		
	2013	2019	2029	2013	2019	2029
Northbound	8	9	9	13	18	26
Southbound	12	17	26	9	9	9

(Source: Strategic transport model, 2014)

6.1.5 Traffic crashes

The frequency of crashes on both Pennant Hills Road and the Pacific Highway would be expected to increase should traffic continue to grow with no modification to the road network within the project area. The potential for crashes – indicated by the crash rates per vehicle kilometre travelled in **Section 4.1.1** – would remain. On Pennant Hills Road, crashes involving rear end collisions would be expected to continue to frequently occur.

Traffic on the road network within and surrounding the project area is expected to grow at a rate of between around one and two per cent per annum should the project not be constructed. By 2029, this increase in traffic could increase crash frequencies and costs.

If the increase in accident frequency was proportional to increase in traffic then accidents on Pennant Hills Road would increase by around 20 per cent with annual costs of these accidents increasing from $3.7 million to $4.6 million per kilometre.

In congested conditions drivers can become frustrated as their ability to travel at their desired speed is impaired; often more risks are taken and crashes occur more frequently as a result. Similarly a reduction in the gap between vehicles would increase the difficulty for vehicles joining and exiting Pennant Hills Road via local roads and property accesses; motorists may take greater risks when joining and exiting as the opportunities to do so become less frequent.

In summary, on this basis the forecast growth in traffic on the existing road network within the project area would be expected to result in a considerable increase in the total number and cost of crashes occurring were the project not constructed.

6.1.6 Public transport services

Current public transport options in the project area comprise buses and trains, as described in **Section 3.2.3**.

An increase in vehicles on the existing road network within the project area would result in lower travel speeds on the Pennant Hills Road corridor and associated increased delays at intersections. If the project was not constructed, the following impacts to public transport services in the project area would potentially be experienced:

- Buses:
    - An increase in bus service travel times due to slower travel speeds and increased intersection delays.
    - More frequent delays to services caused by traffic incidents and congestion in the project area.
    - The potential for crashes caused by buses stopping on Pennant Hills Road to pick-up and drop-off passengers would increase in proportion to the expected growth in traffic.
    - Longer travel times to and from bus stops by supplementary travel modes (eg car passenger, walking to / from bus stop, etc) due to an increase in traffic volumes, slower travel speeds and increased intersection delays.
    - Reduced amenity for bus users waiting at stops. An increase in traffic would result in impacts including a reduction in pedestrian roadside safety.
- Rail services:
    - Longer travel times for rail passengers travelling to and from Beecroft, Pennant Hills, Thornleigh and Normanhurst train stations by car, bus, walking and cycling, due to an increase in traffic volumes, slower travel speeds and increased intersection delays.

6.1.7 Walking and cycling

If the project was not constructed, the following impacts to walking and cycling in the project area would potentially be experienced:

- Walking:
  - Reduced overall amenity throughout the project area including a reduction in pedestrian safety.
- Cycling:
  - Increased delays at intersections for on road cyclists due to an increase in traffic volumes travelling along the corridor.
  - Reduced cyclist road safety; increased potential for accidents with other road users throughout the project area caused by an increase in traffic on the existing road network.
  - Reduced overall amenity throughout the project area including a reduction in safety for on road cyclists.

6.2 Hills M2 Motorway corridor

6.2.1 Traffic volumes and patterns

Anticipated peak hour traffic volumes on the Hills M2 Motorway, east and west of Pennant Hills Road, in 2013, 2019 and 2029 are presented in **Table 6-8** and **Table 6-9** respectively. Traffic growth increases steadily from 2013 to 2019 and 2029 without construction of the project.

Table 6-8 Comparison of peak hour traffic volumes (2013, 2019 and 2029 without project) – Hills M2 Motorway, east of Pennant Hills Road

Direction	Light vehicles			Heavy vehicles		
	2013	2019	2029	2013	2019	2019
AM Peak Hour						
Eastbound	3,750	4,190	4,490	390	340	360
Westbound	2,000	2,020	2,140	170	180	240
PM Peak Hour						
Eastbound	2,500	2,590	2,840	170	200	230
Westbound	3,900	4,290	4,700	350	330	390

(Source: Austraffic, 2013; Strategic transport model, 2014)

Table 6-9 Comparison of peak hour traffic volumes (2013, 2019 and 2029 without project) – Hills M2 Motorway, west of Pennant Hills Road

Direction	Light vehicles			Heavy vehicles		
	2013	2019	2029	2013	2019	2029
AM Peak Hour						
Eastbound	3,700	4,250	4,860	490	480	510
Westbound	2,640	2,730	3,030	240	260	350
PM Peak Hour						
Eastbound	2,990	3,140	3,520	240	290	360
Westbound	3,740	4,110	4,530	430	450	490

(Source: Austraffic, 2013; Strategic transport model, 2014)

6.2.2 Roadway level of service

A comparison of the mid-block traffic levels of service on the Hills M2 Motorway, east and west of Pennant Hills Road, under the 'without project' scenario are provided for 2019 and 2029 in **Table 6-11** and **Table 6-11** respectively.

Table 6-10 Mid-block traffic volumes and LoS (2019 and 2029 without project) – Hills M2 Motorway, east of Pennant Hills Road

Direction	Mid-Block Capacity	2019 – Without Project				2029 – Without Project			
		Light Vehicles	Heavy Vehicles	V/C	LoS	Light Vehicles	Heavy Vehicles	V/C	LoS
AM Peak Hour									
Eastbound	6,900	4,190	340	0.75	D	4,490	360	0.80	D
Westbound	6,900	2,020	180	0.37	B	2,140	180	0.39	B
PM Peak Hour									
Eastbound	6,900	2,590	200	0.46	C	2,840	200	0.50	C
Westbound	6,900	4,290	330	0.76	D	4,700	330	0.82	D

The analysis shows that westbound traffic on the Hills M2 Motorway, east of Pennant Hills Road, would be operating within the theoretical design capacity.

Table 6-11 Mid-block traffic volumes and LoS (2019 and 2029 without project) – Hills M2 Motorway, west of Pennant Hills Road

Direction	Mid-Block Capacity	2019 – Without Project				2029 – Without Project			
		Light Vehicles	Heavy Vehicles	V/C	LoS	Light Vehicles	Heavy Vehicles	V/C	LoS
AM Peak Hour									
Eastbound	6,900	4,250	480	0.82	D	4,860	510	0.92	E
Westbound	4,600	2,730	260	0.76	D	3,030	350	0.88	D
PM Peak Hour									
Eastbound	6,900	3,140	290	0.58	C	3,520	360	0.66	C
Westbound	4,600	4,120	450	1.18	F	4,530	490	1.29	F

The analysis shows that westbound traffic on the Hills M2 Motorway, west of Pennant Hills Road, would be operating with peak traffic volumes above the theoretical design capacity in 2019. Eastbound traffic on the Hills M2 Motorway west of Pennant Hills Road is expected to approach the theoretical design capacity in 2029 during the AM peak.

6.2.3 Intersection level of service

The assessment of the relevant intersection on the corridor, namely the Hills M2 Motorway / Pennant Hills Road interchange, is detailed in **Section 6.1**.

6.2.4 Travel times

A comparison of average travel times along the Hills M2 Motorway between Pennant Hills Road and Windsor Road interchanges, for the 'without project' scenarios was provided from the strategic transport model and is presented in **Table 6-12**. The 2013 travel time from the strategic model is also presented for comparison.

The results indicate that, without the project, the AM peak and the eastbound PM peak travel times remain largely unchanged from the existing. However, during the 2019 PM peak, the westbound average travel times are estimated to increase by nine minutes. By 2029, the average travel time for this movement is expected to increase by a further 11 minutes.

Table 6-12 Comparison of average travel time (2013, 2019 and 2029 without project) – Hills M2 Motorway Corridor, between Pennant Hills Road and Windsor Road interchanges

Direction	AM Peak Hour Average Travel Time (min)			PM Peak Hour Average Travel Time (min)		
	2013	2019	2029	2013	2019	2029
Eastbound	2	2	3	2	2	2
Westbound	2	2	2	6	15	26

(Source: Strategic transport model, 2014)

6.2.5 Traffic crashes

The frequency of crashes on the Hills M2 Motorway would be expected to increase in proportion to forecast traffic growth in the future. The potential for crashes – indicated by the crash rates per vehicle kilometre travelled in **Section 4.2.1** – would remain, with rear end collisions expected to continue to contribute to the majority of incidents.

Traffic on the Hills M2 Motorway is expected to grow at a rate of around two per cent per annum in a scenario where the project is not constructed. By 2029, this growth would create a proportional rise in crash frequencies and costs:

- Crashes on the Hills M2 Motorway would be expected to increase from an average of 30 to 39 per annum.
- The corresponding annual cost of crashes on the Hills M2 Motorway would rise from $1.0 million to $1.35 million per kilometre.

These estimates assume that the likelihood and severity of crashes remains consistent with historic trends despite a significant increase in traffic.

In congested conditions drivers can become frustrated as their ability to travel at their desired speed is impaired; often more risks are taken and crashes occur more frequently as a result. Similarly a reduction in the gap between vehicles would increase the difficulty for vehicles joining and exiting the motorway; motorists may take greater risks when joining and exiting at interchanges as a result.

The above analysis has been undertaken assuming the future frequency, type, and severity of crashes on the Hills M2 Motorway would be consistent with historic trends. In summary, on this basis the forecast growth in traffic on the Hills M2 Motorway would be expected to result in both the total number and cost of crashes increasing.

6.2.6 Public transport services

The dedicated the bus lane along the Hills M2 Motorway is solely for public transportation purposes, which results in it being largely unaffected by increasing capacity constraints on lanes occupied by general traffic.

6.2.7 Walking and cycling

Cycling on the corridor is likely to be unaffected irrespective of whether the project is implemented. Cyclists are permitted to use a portion of road space that is not used as a travel lane by general traffic. There is however, the potential that as traffic volumes and density on the corridor increase, a greater rate of incidents will occur which require vehicles to be stored in the road shoulder current utilised by cyclists.

Walking is not permitted on the motorway and as such would not be impacted upon regardless of whether the project proceeds.

6.3 M1 Pacific Motorway corridor

6.3.1 Traffic volumes and patterns

Anticipated peak hour traffic volumes on the M1 Pacific Motorway, between Ku-Ring-Gai Interchange and Windy Banks Interchange, in the 2013, 2019 and 2029 'without project' scenarios are presented in **Table 6-13**.

Table 6-13 Comparison of peak hour traffic volumes (2013, 2019 and 2029 without project) – M1 Pacific Motorway, between Ku-Ring-Gai Interchange and Windy Banks Interchange

Direction	Light vehicles			Heavy vehicles		
	2013	2019	2029	2013	2019	2029
AM Peak Hour						
Northbound	1,460	1,580	1,610	220	270	320
Southbound	3,410	3,920	4,620	250	290	360
PM Peak Hour						
Northbound	3,590	4,060	4,580	230	270	340
Southbound	1,900	2,000	2,030	180	230	310

(Source: Strategic transport model, 2014)

6.3.2 Roadway level of service

Mid-block traffic levels of service on the M1 Pacific Motorway, between Ku-ring-gai Chase Road interchange and Windy Banks interchange, under the 2019 and 2029 'without project' scenarios are provided in **Table 6-14**.

Table 6-14 Mid-block traffic volumes and LoS (2019 and 2029 without project) – M1 Pacific Motorway, between Ku-ring-gai Chase Road interchange and Windy Banks interchange

Direction	Mid-Block Capacity	2019 – Without Project				2029 – Without Project			
		Light Vehicles	Heavy Vehicles	V/C	LoS	Light Vehicles	Heavy Vehicles	V/C	LoS
AM Peak Hour									
Northbound	6,900	1,580	270	0.34	B	1,610	320	0.37	B
Southbound	6,900	3,920	290	0.69	C	4,620	360	0.82	D
PM Peak Hour									
Northbound	6,900	4,060	270	0.70	D	4,580	340	0.81	D
Southbound	6,900	2,000	230	0.38	B	2,030	310	0.42	B

Growth in background traffic results in a decreased level of mid-block performance in 2019 and 2029; however traffic would still be within the theoretical design capacity of the roadway and operate at a reasonable level of service in the peak hours.

6.4 Westlink M7 Motorway corridor

6.4.1 Traffic volumes and patterns

Anticipated peak hour traffic volumes on two sections of the Westlink M7 Motorway in the 2013, 2019 and 2029 'without project' scenarios are presented in **Table 6-15**.

Table 6-15 Comparison of peak hour traffic volumes (2013, 2019 and 2029 without project) – Westlink M7 Motorway

Location	Direction	Light vehicles			Heavy vehicles		
		2013	2019	2029	2013	2019	2029
AM Peak Hour							
Old Windsor Road to Hills M2 Motorway	Eastbound	1,290	1,760	2,350	200	180	230
	Westbound	1,360	1,580	1,800	160	200	250
The Horsley Drive to Old Wallgrove Road	Northbound	2,190	3,260	3,560	470	730	720
	Southbound	2,210	2,680	3,270	470	460	510
PM Peak Hour							
Old Windsor Road to Hills M2 Motorway	Eastbound	1,590	1,910	2,090	120	200	260
	Westbound	2,130	2,890	3,440	220	270	300
The Horsley Drive to Old Wallgrove Road	Northbound	2,330	3,350	3,880	340	540	560
	Southbound	2,500	3,340	3,570	370	490	500

(Source: Austraffic, 2013; Strategic transport model, 2014)

6.4.2 Roadway level of service

Mid-block traffic levels of service on two sections of the Westlink M7 Motorway under the 2019 'without project' scenario are provided in **Table 6-16**.

Table 6-16 Mid-block traffic volumes and LoS (2019 without project) – Westlink M7 Motorway

Location	Direction	Mid-Block Capacity	Light Vehicles	Heavy Vehicles	V/C	LoS
AM Peak Hour						
Old Windsor Road to Hills M2 Motorway	Eastbound	4,600	1,760	180	0.50	C
	Westbound	4,600	1,580	200	0.47	B
The Horsley Drive to Old Wallgrove Road	Northbound	4,600	3,260	730	1.17	F
	Southbound	4,600	2,680	460	0.88	D
PM Peak Hour						
Old Windsor Road to Hills M2 Motorway	Eastbound	4,600	1,910	200	0.55	C
	Westbound	4,600	2,890	270	0.80	D
The Horsley Drive to Old Wallgrove Road	Northbound	4,600	3,350	540	1.07	F
	Southbound	4,600	3,340	490	1.04	F

Growth in background traffic results in a decreased level of mid-block performance in 2019 on the Westlink M7 Motorway. While traffic on the section between Old Windsor Road and the Hills M2 Motorway would still within the theoretical design capacity of the roadway and would operate at a reasonable level of service in the peak hours, northbound traffic on the section between The Horsley Drive and Old Wallgrove Road would be above the theoretical design capacity in the 2019 peak hours. Southbound traffic on this section is also shown to be exceeding the theoretical design capacity in the 2019 PM peak hour.

Mid-block traffic levels of service on two sections of the Westlink M7 Motorway under the 2029 'without project' scenario are provided in **Table 6-17**.

Table 6-17 Mid-block traffic volumes and LoS (2029 without project) – Westlink M7 Motorway

Location	Direction	Mid-Block Capacity	Light Vehicles	Heavy Vehicles	V/C	LoS
AM Peak Hour						
Old Windsor Road to Hills M2 Motorway	Eastbound	4,600	2,350	230	0.66	C
	Westbound	4,600	1,800	250	0.55	C
The Horsley Drive to Old Wallgrove Road	Northbound	4,600	3,560	720	1.23	F
	Southbound	4,600	3,270	510	1.04	F
PM Peak Hour						
Old Windsor Road to Hills M2 Motorway	Eastbound	4,600	2,090	260	0.62	C
	Westbound	4,600	3,440	300	0.94	E
The Horsley Drive to Old Wallgrove Road	Northbound	4,600	3,880	560	1.20	F
	Southbound	4,600	3,570	500	1.10	F

By 2029, traffic in both directions on the section between The Horsley Drive and Old Wallgrove Road is shown as exceeding the theoretical design capacity in the peak hours. The section between Old Windsor Road and the Hills M2 Motorway would still operate within the theoretical design capacity of the roadway, although the westbound direction would be approaching the theoretical design capacity in the PM peak hour.

6.5 Surrounding road network: traffic volumes and patterns

Forecast 2019 and 2029 AWDT traffic volumes for the 'without project' scenario have been analysed and compared to the 2013 existing scenario volumes at key links in the wider road network. **Table 6-18** and **Table 6-19** show the light and heavy vehicle AWDT volume comparisons.

Table 6-18 Comparison of 2013, 2019 and 2029 light vehicle volumes on the surrounding road network (without project)

Road	Location	AWDT (Northbound / Eastbound)			AWDT (Southbound / Westbound)		
		2013	2019	2029	2013	2019	2029
Pacific Highway	Pennant Hills Road to Woolcott Avenue	14,100	16,650	17,400	12,050	14,300	15,150
Pacific Highway	M1 Pacific Motorway interchange to Redleaf Avenue	26,700	31,150	33,200	30,000	33,800	35,350
Pacific Highway	North of Bobbin Head Road	29,300	33,700	35,150	24,650	28,150	29,950
Castle Hill Road	New Line Road to Edward Bennett Drive	15,000	18,350	21,000	13,050	15,900	18,250
Boundary Road	North of Pennant Hills Road	13,500	17,550	19,400	10,400	11,100	11,700

Road	Location	AWDT (Northbound / Eastbound)			AWDT (Southbound / Westbound)		
		2013	2019	2029	2013	2019	2029
Beecroft Road	Hills M2 Motorway interchange to Cheltenham Road	21,650	24,600	26,750	17,250	18,600	19,750
Beecroft Road	South of Hills M2 Motorway	19,850	22,400	23,750	14,300	15,550	15,700
North Rocks Road	West of Pennant Hills Road	16,400	16,900	17,350	13,200	13,950	14,250
Carlingford Road	East of Pennant Hills Road	12,100	14,250	15,950	19,100	21,300	23,150
Lane Cove Road	South of Hills M2 Motorway	22,000	29,700	33,550	22,400	25,500	29,700
Epping Road	West of Delhi Road	35,950	45,950	51,300	28,100	31,450	34,100
Pennant Hills Road (Cumberland Highway)	Marsden Road to Carlingford Road	24,700	28,250	30,350	33,750	37,700	39,700
Emert Street (Cumberland Highway)	North of Great Western Highway	20,850	24,450	29,050	24,700	30,550	34,350
Westlink M7 Motorway	Old Windsor Road to Hills M2 Motorway	20,120	28,000	37,800	20,630	28,700	38,700
Old Windsor Road	Toongabbie Creek crossing	17,800	21,300	24,150	20,550	24,150	25,850
Abbott Road	West of Old Windsor Road	12,700	15,100	18,750	14,400	16,450	20,000
Abbott Road	East of Old Windsor Road	14,750	16,000	16,950	14,750	14,450	14,050
Woodville Road	North of Christina Road	16,750	19,350	21,300	18,000	21,500	22,950
Hume Highway	South of Elizabeth Drive	28,050	33,450	37,500	25,550	29,600	31,900
Westlink M7 Motorway	The Horsley Drive to Old Wallgrove Road	27,890	38,700	47,000	28,370	39,400	47,900
Cowpasture Road	Westlink M7 Motorway Interchange to Green Valley Road	15,900	19,700	22,450	15,950	20,250	23,600

(Source: Strategic transport model; 2014)

Table 6-19 Comparison of 2013, 2019 and 2029 heavy vehicle volumes on the surrounding road network (without project)

Road	Location	AWDT (Northbound / Eastbound)			AWDT (Southbound / Westbound)		
		2013	2019	2029	2013	2019	2029
Pacific Highway	Pennant Hills Road to Woolcott Avenue	900	1,050	1,200	550	550	650
Pacific Highway	M1 Pacific Motorway interchange to Redleaf Avenue	2,450	2,900	3,600	4,050	4,550	5,450
Pacific Highway	North of Bobbin Head Road	2,400	2,850	3,450	3,500	3,950	4,800
Castle Hill Road	New Line Road to Edward Bennett Drive	550	750	950	650	750	1,050
Boundary Road	North of Pennant Hills Road	850	1,100	1,400	900	1,100	1,400
Beecroft Road	Hills M2 Motorway interchange to Cheltenham Road	1,000	1,300	1,850	750	800	1,000
Beecroft Road	South of Hills M2 Motorway	900	1,100	1,600	400	450	600
North Rocks Road	West of Pennant Hills Road	1,250	1,200	1,200	600	650	700
Carlingford Road	East of Pennant Hills Road	400	450	600	800	750	900
Lane Cove Road	South of Hills M2 Motorway	2,150	2,650	3,250	2,100	2,450	3,300
Epping Road	West of Delhi Road	2,800	3,450	4,150	1,850	2,300	2,800
Pennant Hills Road (Cumberland Highway)	Marsden Road to Carlingford Road	3,100	3,250	3,550	5,200	5,250	5,500
Emert Street (Cumberland Highway)	North of Great Western Highway	2,700	2,700	3,050	3,000	3,450	4,000
Westlink M7 Motorway	Old Windsor Road to Hills M2 Motorway	3,370	4,700	6,300	3,380	4,700	6,300
Old Windsor Road	Toongabbie Creek crossing	1,500	1,650	2,050	2,150	2,350	2,900
Abbott Road	West of Old Windsor Road	1,200	1,500	1,600	900	1,100	1,500
Abbott Road	East of Old Windsor Road	1,350	1,500	1,500	1,050	1,050	1,100
Woodville Road	North of Christina Road	2,050	2,050	2,450	2,150	1,950	2,350
Hume Highway	South of Elizabeth Drive	1,850	2,300	2,950	1,050	1,250	1,800
Westlink M7 Motorway	The Horsley Drive to Old Wallgrove Road	7,310	10,200	12,400	7,510	10,400	12,600
Cowpasture Road	Westlink M7 Motorway Interchange to Green Valley Road	1,500	1,000	1,100	2,200	1,650	1,700

(Source: Strategic transport model; 2014)

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7.0 Construction traffic impact assessment

This section provides details of the traffic impact assessment that was completed for the construction impacts of the project. Mid-blocks and intersections discussed in this chapter are shown on **Figure 6-1**.

7.1 Description of construction activities

The majority of the construction footprint is located underground within the main alignment tunnels; however surface areas would be required to support tunnelling activities, and to construct the interchanges, tunnel portals, the Hills M2 Motorway integration, the M1 Pacific Motorway tie-in, the motorway operations complex, northern and southern ventilation facilities, tunnel support facilities and other ancillary operations buildings and facilities.

Construction of the project is expected to occur over a period of approximately four years and would include (but not be limited to) the following:

- Enabling and temporary works, including construction power, water supply, site establishment, demolition works, property and utility adjustments and public transport modifications (if required).
- Construction of the road tunnels, interchanges, intersections and roadside infrastructure.
- Haulage of spoil generated during tunnelling and excavation activities.
- Fit-out of the road tunnels and support infrastructure, including ventilation and emergency response systems.
- Construction and fit-out of the motorway control centre.
- Realignment, modification or replacement of surface roads, bridges and/or underpasses.
- Environmental management and pollution control facilities for the project.

Civil works including earthworks, underpasses and retaining structures would be required at multiple locations along the project. This would include the construction of the northern and southern interchange to form on and off-ramps, construction of above-ground surface infrastructure including ventilation infrastructure and the motorway control centre, tie in works at the M1 Pacific Motorway and integration works at the Hills M2 Motorway. Associated surface road works may require temporary traffic or pedestrian detours, road occupation or temporary road closures, and these would be undertaken in accordance with approvals by Roads and Maritime, councils and Traffic Management Centre, as relevant.

Temporary or permanent impacts to bus and cyclist infrastructure along the Hills M2 Motorway may occur, depending on the preferred design of the integration works and the construction methods required. Construction ancillary facilities would be required to support the construction of the project. The ancillary facilities include the launch and retrieval of tunnelling machinery, spoil removal, general civil works, service construction, tunnel fit-out, water quality treatment, general construction support and offices. There are eleven site locations proposed for use during construction. These are outlined in **Table 7-1** and illustrated in **Figure 7-1**.

Temporary works are proposed at various stages of construction, such as temporary diversions for road, cycle and pedestrian traffic near work areas, and alternative arrangements where property accesses may be temporarily disrupted.

Tunnelling and associated above-ground tunnelling support activities are proposed to operate 24 hours a day, seven days a week. Other activities that would significantly reduce the performance of the road network would be scheduled for periods of typically lower traffic volumes, where feasible and reasonable, so as to minimise potential disruption to regional and local traffic network.

Heavy vehicles would be required to deliver and remove construction plant, equipment and materials as well as remove waste from the project site. Waste removal would include general construction waste, office waste and spoil from tunnelling activities. Further details on waste management are provided in **Section 8.3** of the environmental impact statement (EIS).

The construction period would also result in increased use of light vehicles on the surrounding road network associated with the construction workforce. Employee worksite transfer would likely occur in the peak periods.

Table 7-1 Construction site locations

No.	Site	Site Location
C1	Windsor Road compound	Windsor Road / Hills M2 Motorway
C2	Darling Mills Creek compound	Under Darling Mills Creek
C3	Barclay Road compound	Barclay Road / Perry Street
C4	Yale Close compound	End of Duncan Place
C5	Southern interchange compound	Hills M2 Motorway / Pennant Hills Road
C6	Wilson Road compound	Wilson Road / Pennant Hills Road
C7	Trelawney Street compound	Trelawney Street / Pennant Hills Road
C8	Pioneer Avenue compound	Adjacent to Northern Railway Line on Pioneer Avenue
C9	Northern interchange compound	Adjacent to M1 Pacific Motorway / Pennant Hills Road north of Eastbourne Avenue, Wahroonga.
C10	Bareena Avenue compound	Bareena Avenue / Woonona Ave North, Wahroonga
C11	Junction Road compound	Junction Road / Coonanbarra Road

Surface construction works (such as for ancillary infrastructure, portal works, and tie-in works at the M1 Pacific Motorway and integration works at the Hills M2 Motorway) and the establishment of construction sites with their associated entry / exit points may result in a number of traffic related impacts including alterations to:

- Existing property access.
- Existing pedestrian and cyclist access and movements.
- The location of existing bus stops.
- The local traffic environment.

Any temporary road closures associated with the works are proposed to occur outside of peak traffic periods so as to not impact on peak traffic conditions on the road network.

Major construction works are primarily accessed from Pennant Hills Road, Hills M2 Motorway and M1 Pacific Motorway to minimise impact on local roads, while site compounds are located to provide the most direct access to and from Pennant Hills Road as possible, allowing vehicles to access and egress via the strategic road network to minimise impact on local roads.

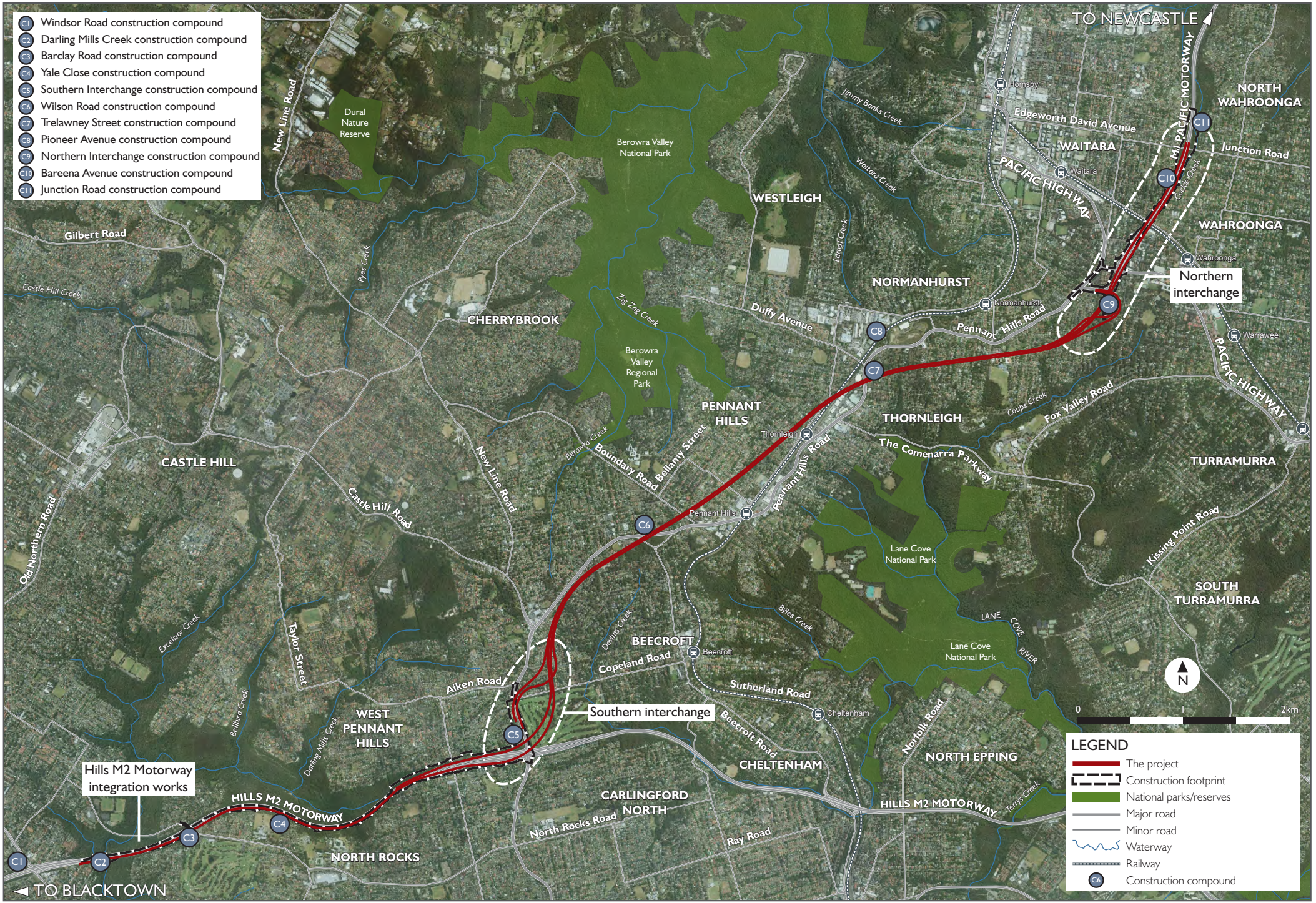

Figure 7-1 Overview of construction footprint and ancillary facilities

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7.1.1 Construction traffic

Construction traffic generated during the construction of the project has been divided into three categories:

- Removal of spoil generated by construction activities.
- Heavy vehicle deliveries and other heavy vehicles attracted by construction activities.
- Light vehicles attracted to construction compounds.

Sites for the disposal of spoil in excess of the requirements of the project would be confirmed during detailed design. However, the following sites with capacity for spoil disposal have been identified:

- ADI site, St Marys.
- Gosford Quarry.
- Hornsby Quarry site.
- CSR Quarry.
- Defence precinct Schofields.
- Great Southern Rock (GSR) Quarry (Sandy Point Quarry).

For the purposes of defining a worst case scenario for construction traffic, two scenarios have been considered, being all spoil being transported to a site located north of the project via Pennant Hills Road and the M1 Pacific Motorway (Scenario A) and all spoil being transported to a site south or west of the project via Pennant Hills Road and the Hills M2 Motorway (Scenario B).

In reality, there is reasonable potential that spoil would be disposed of at more than one site, with spoil transportation occurring in both a northbound and a southbound / westbound direction. By modelling and assessing both scenarios separately, and assuming all spoil transport in each direction, the assessment of potential spoil haulage impacts is expected to be a conservative, worst case assessment approach.

The impacts of construction have been assessed under both northbound and southbound spoil haulage scenarios. It has been assumed that delivery of concrete would largely originate from batching plants in the Thornleigh region, although other sources may also be required. Other materials required for construction would generally utilise the arterial road network to access the various construction sites. The proposed haulage routes are illustrated in **Figure 7-2**, with haulage from the tunnelling support facilities illustrated in **Figure 7-3**, **Figure 7-4**, **Figure 7-5** and **Figure 7-6**.

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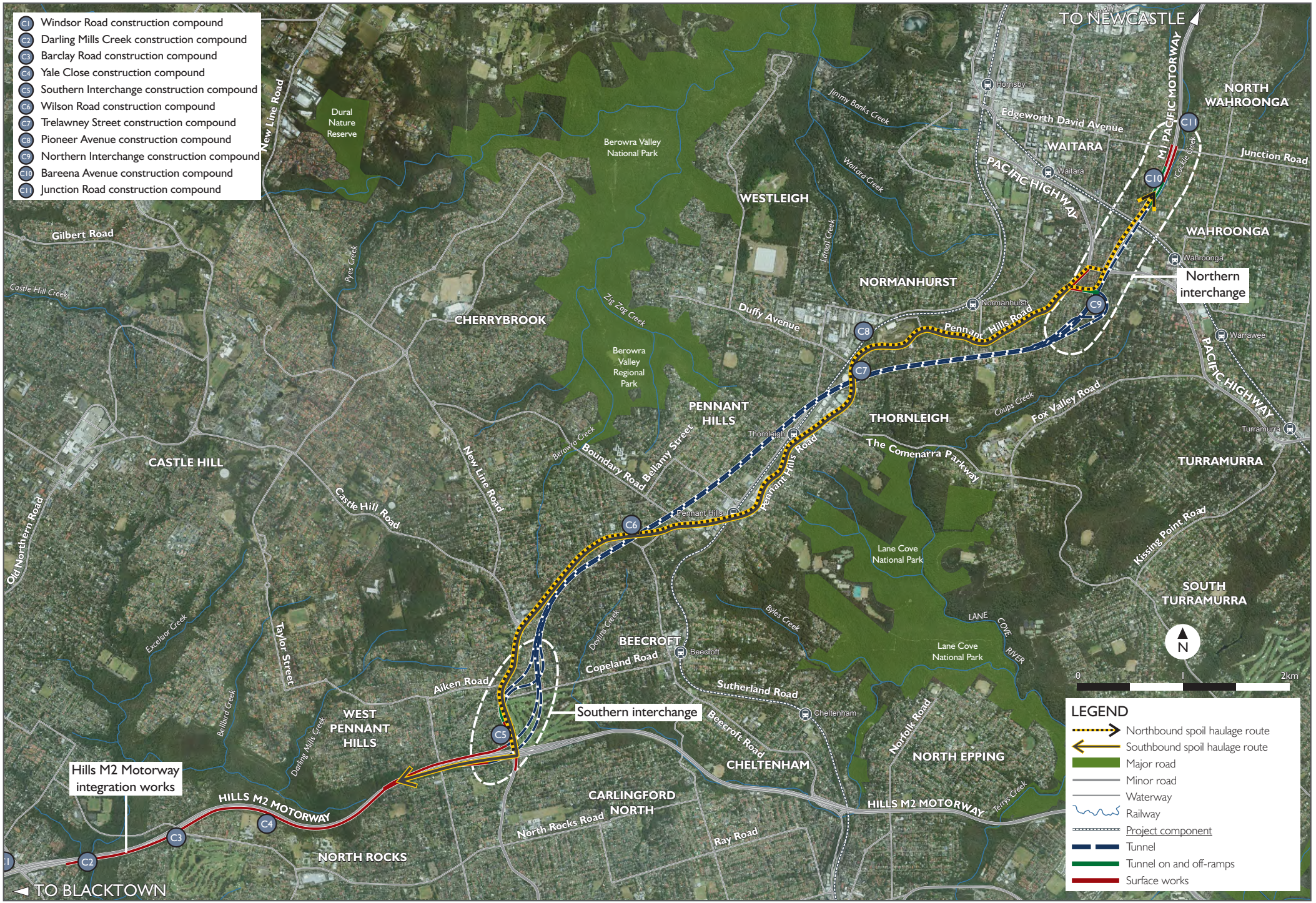

Figure 7-2 Spoil haulage routes

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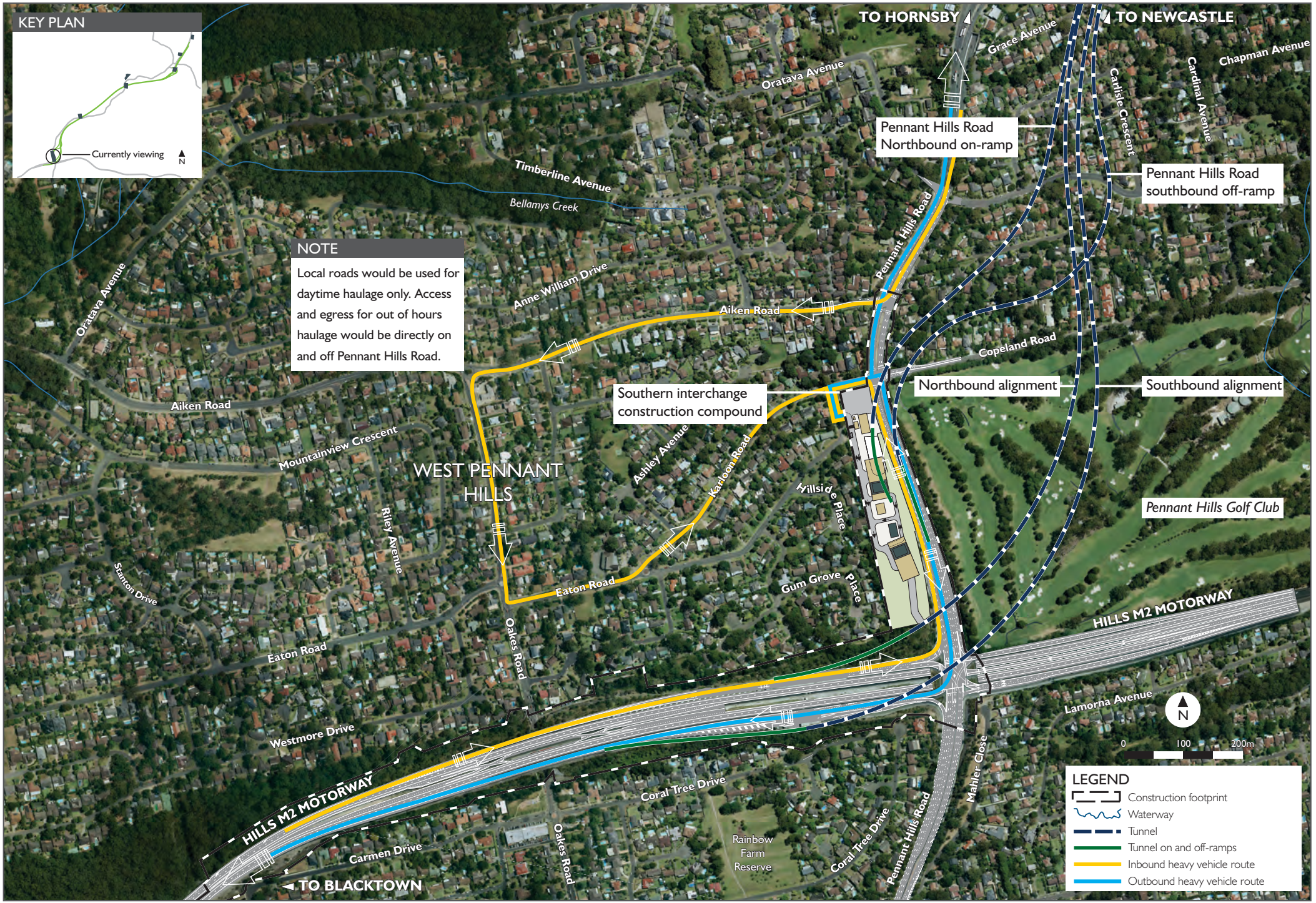

Figure 7-3 Southern interchange construction compound spoil haulage routes

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Figure 7-4 Wilson Road construction compound spoil haulage routes

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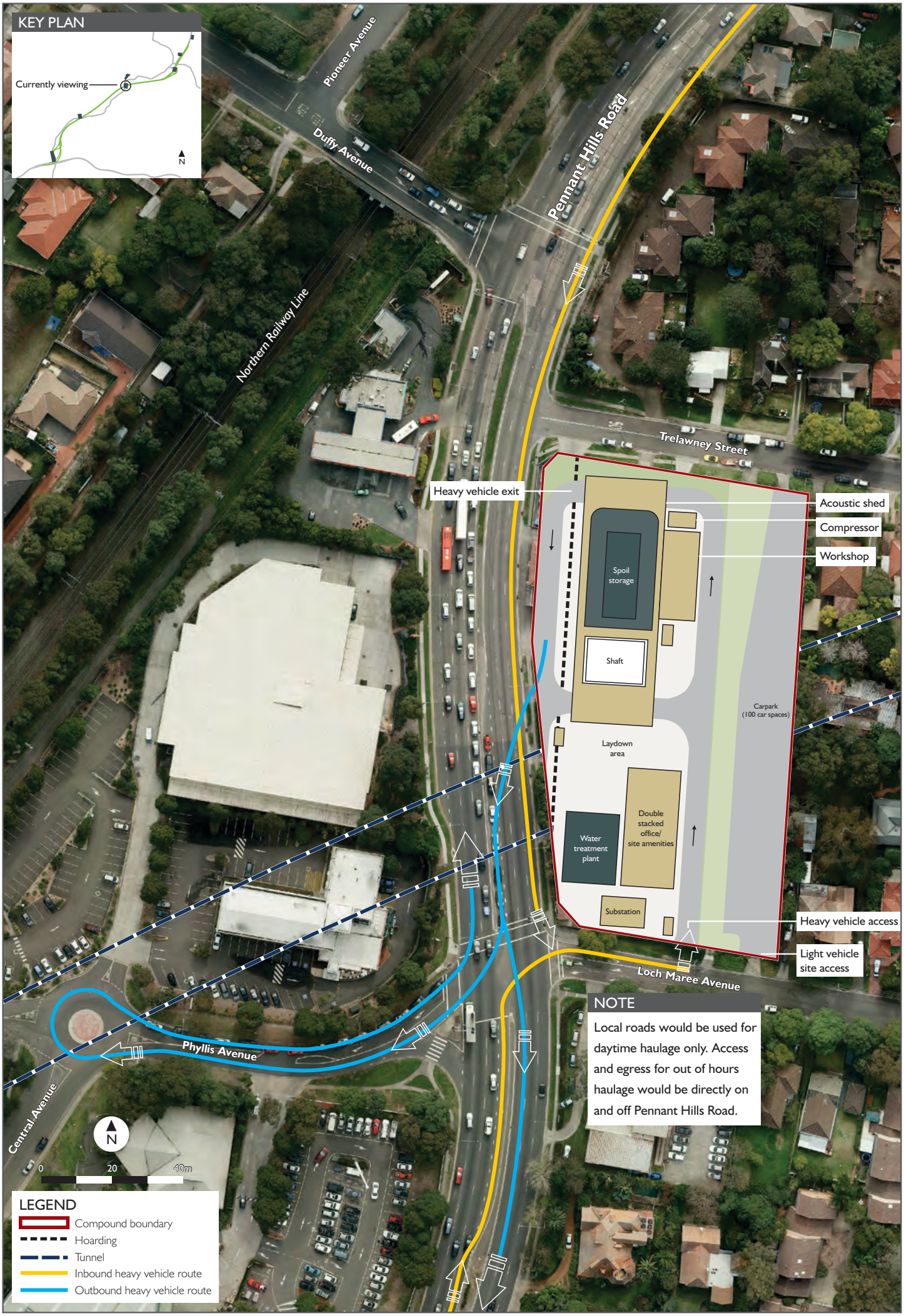

Figure 7-5 Trelawney Street construction compound spoil haulage routes

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Figure 7-6 Northern interchange construction compound spoil haulage routes

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7.1.1.1 Construction traffic (tunnel construction)

Proposed construction volumes for the site locations along Pennant Hills Road, including both heavy and light vehicles, are described in **Table 7-2** and **Table 7-3** respectively. The highest volumes of both heavy and light construction vehicles will originate from the southern and northern interchange compounds and both intermediate shaft compounds, located at the intersections of Pennant Hills Road / Wilson Road and Pennant Hills Road / Trelawney Street.

The volume of construction traffic is indicative and based on the preferred tender design. Whilst the exact numbers would be subject to change based on detailed design and refinements of construction methods, the project would to aim to result in a similar level of intersection performance to that predicted within this assessment.

Table 7-2 Heavy construction vehicles

Site	Location	Excavation Phase		
		AM peak veh/hr	PM peak veh/hr	Daily vehicles
Southern interchange compound	Hills M2 Motorway / Pennant Hills Road	25	28	740
Wilson Road compound	Wilson Road / Pennant Hills Road	23	26	600
Trelawney Street compound	Trelawney Street / Pennant Hills Road	23	26	570
Northern interchange compound	Adjacent to M1 Pacific Motorway / Pennant Hills Road north of Eastbourne Avenue	26	29	720
Bareena Avenue compound	M1 Pacific Motorway (Between Alexandria Avenue Overpass and Edgeworth David Drive Overpass)	3	4	20
Junction Road compound	Junction Road / Coonanbarra Road	0	0	1
Pioneer Avenue compound	Adjacent to Northern Railway Line on Pioneer Road	4	4	24
Total		**104**	**117**	**2,675**

(Source: Lend Lease Bouygues JV, 2013)

Table 7-3 Light construction vehicles

Site	Location	Excavation Phase		
		AM peak veh/hr	PM peak veh/hr	Daily vehicles
Southern interchange compound	Hills M2 Motorway / Pennant Hills Road	12	12	165
Wilson Road compound	Wilson Road / Pennant Hills Road	8	8	100
Trelawney Street compound	Trelawney Street / Pennant Hills Road	8	8	100
Northern interchange compound	Adjacent to M1 Pacific Motorway / Pennant Hills Road north of Eastbourne Avenue	10	10	100
Bareena Avenue compound	M1 Pacific Motorway (Between Alexandria Avenue Overpass and Edgeworth David Drive Overpass)	3	3	25
Junction Road compound	Junction Road / Coonanbarra Road	16	16	100
Pioneer Avenue compound	Adjacent to Northern Railway Line on Pioneer Road	98	98	650
Total		**155**	**155**	**1,240**

(Source: Lend Lease Bouygues JV, 2013)

The site compounds are located to provide convenient access from the motorways and Pennant Hills Road which allows vehicles to access and egress via the strategic road network to minimise impact to the local road network.

A central construction workforce parking area would be provided, with workers transported to and from the various worksites by bus. The parking area is proposed to be located off Pioneer Road adjacent to the Northern Railway Line, with a capacity of up to 650 vehicles. At the Junction Road compound, 50 car spaces are proposed to be provided. The transfer of employees to and from the construction compounds has been assumed to occur during peak hours and has been included as part of this assessment.

7.1.1.2 Construction traffic (Hills M2 Motorway integration works)

The following construction traffic movements are proposed for works associated with the implementation of the Hills M2 Motorway integration works:

- The initial setup of the compound and pier work area underneath the Darling Mills Creek bridge would require the use of the Ventura Road track. Based on the recent widening of the bridge for the Hills M2 Motorway Upgrade project, this would entail two one-off vehicle movements to deliver an excavator and a piling rig in and out of the area, and approximately ten light vehicle movements per day for a period of around four weeks. These light vehicles would be used to deliver small miscellaneous equipment that cannot be carried in by hand.
- The Barclay Road compound is proposed to be accessed off Perry Street. Daily traffic is anticipated to be an average of 26 light vehicles and 25 heavy vehicles with no greater than four heavy movements per hour during daytime hours.
- For the Hills M2 integration work, the following worksite vehicle movements are predicted (average daily):
    - Windsor Road to Barclay Road eastbound – 40 heavy vehicles / 300 light vehicles
    - Barclay Road to Pennant Hills Road westbound – 50 heavy vehicles / 360 light vehicles

Of these, it is anticipated that up to 180 heavy and light vehicle movements would occur at night. These would include general light vehicles, floats, tipper trucks, truck and dog, flatbed crane trucks, concrete trucks and asphalting.

Around 40 per cent of vehicles are assumed to be associated with excavation and delivery of processed sandstone/quarry materials. Truck movements associated with this would be primarily only on the motorway for the length of the project extent on the Hills M2 Motorway.

7.1.2 Construction compounds

7.1.2.1 Windsor Road compound

Site location and construction activities

The Windsor Road compound would be located on the north-western side of the Windsor Road / Hills M2 Motorway interchange. The site was formerly utilised as a compound for recently completed Hills M2 Motorway Upgrade project and currently comprises vacant open space.

An indicative construction site layout for the Windsor Road compound is shown in **Figure 7-7** and the construction activities sequence is outlined in **Table 7-4**.

Table 7-4 Windsor Road compound indicative construction program

Construction activity	Indicative construction timeframe																			
	2014				2015				2016				2017				2018			
Site establishment																				
Integration works support																				
Site rehabilitation/landscaping																				

(Source: Lend Lease Bouygues JV, 2014)

Figure 7-7 Indicative Windsor Road construction compound

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Access and egress

The construction compound is proposed to be used as the main site office for the Hills M2 Motorway integration works. Site access and egress would be to and from Torr Street.

Local Road impacts

Local road impacts are anticipated to be minimal as the construction compound is located prior to the residential catchment.

7.1.2.2 Darling Mills Creek compound

Site location and construction activities

The Darling Mills Creek compound would be located within the road reserve adjacent to the Darling Mills Creek viaduct. The site would generally consist of basic amenities for the workforce at the Darling Mills Creek viaduct.

An indicative construction site layout for the Darling Mills Creek compound is shown in **Figure 7-8** and the construction activities sequence is outlined in **Table 7-5**.

Table 7-5 Darling Mills Creek compound indicative construction program

Construction activity	Indicative construction timeframe																			
	2014				2015				2016				2017				2018			
Site establishment																				
Substructure																				
Superstructure																				
Finishing works																				
Site rehabilitation/landscaping																				

(Source: Lend Lease Bouygues JV, 2014)

Access and egress

Primary site access would be provided from the Hills M2 Motorway westbound carriageway at the eastern bridge abutment by construction of a new access track. Access would also be provided from Ventura Road however this would be limited to the delivery and removal of drill rigs and excavation equipment.

Local road impacts

Local road impacts at the Darling Mills Creek compound are anticipated to be minimal. As indicated above impacts should only be anticipated during start up and completion phases relating to the use of the construction compound.

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Figure 7-8 Indicative Darling Mills Creek viaduct construction compound

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